DRAFT - SUBJECT TO REVISION

NOTES ON THE EFFECT OF AGG MOISTURE CONTENT ON CENTRIFUGE KEROSENE EQUIVALENT (CKE) TEST

ALPHA LAB REPORT DATED JANUARY 7, 1991/C. ROBERT BENEDICT
FOR PRESENTATION AT THE ISSA 29TH MEETING R&D COMMITTEE
FEBRUARY 18, 1991

Slurry Seal Design by the surface area method nearly always yields a bitumen rich (too rich) slurry. We suspect that the amount of bitumen added for absorbtion as determined by the CKE test is in error.

The Centrifuge Kerosene Equivalent test measures the percent kerosene absorbtion by the aggregate and is taken as a measure of bitumen absorbtion requirement.

Surface area design was developed for hot mix and asphaltic concrete where the aggregate is hot and bone dry and the bitumen is quite fluid, contains no water, is thin and acts as if it were a solution.

Emulsions on the other hand, are cold and "wet" and consist of solid or semi solid, discreet particles of bitumen which cannot penetrate aggregate pores because (a) the bitumen particle size is larger than the pore size and (b) the aggregate pores are already filled with mix water and emulsifier solution. Bitumen adhesion in wet slurries is a surface phenomenon. Thus, adding bitumen for an absorbtion allowance, when no absorbtion is immediately possible, leads to excess bitumen.

Typical slurry mixes consist of damp aggregate (1 to 6% moisture), added mix water (5-15%) and the bitumen emulsion which contains 4-5% moisture added to the total mix, all added before the aggregate is touched by pure bitumen.

An experiment was performed by comparing the "dry" CKE with partially wet or "damp" Minnesota Granite and Ohio Dolomite with 0, 1 & 2% Portland Cement filler. Table 1 shows the results of these single tests:

	H_2O	Portland Cement		
	%	0%	1%	2%
Minnesota Granite	0	2.99	3.05(+.06)	3.10(+.11)
	1.5	1.80	1.89(+.09)	1.93(+.13)
Ohio Dolomite	0	3.23	3.40(+.17)	3.56(+.33)
	2.0	1.17	1.30(+.13)	1.42(+.25)

TABLE 1: Effect of moisture and cement contents on CKE values.

Figure 1: Plots the effect of moisture content on CKE absorbtion, the cement to cement content and aggregate type.

When dry, the Granite CKE absorbtion due to cement doubles as the cement also doubles; i.e., CKE increases in proportion to cement content and INCREASES with or in proportion to moisture content.

With Limestone, the response is quite different. While the CKE also increases in proportion to the cement content, it does so at a rate TRIPLE that of Granite. Further, the CKE DECREASE with an increase in moisture content, exactly opposite that of Granite!

Figure 2: Plots the overall effect of moisture content on or total CKE values.

Figure 3: Projects the scant data we have here to the point of ZERO CKE at about 3% for Dolomite and 4% for Granite.

In other words, it appears that between 3 and 4% moisture content, there can be no absorbtion of the emulsion into the aggregate. This reasoning may explain why slurry mixes which use surface area design including CKE absorbtion are nearly always too rich.

NOTES:

1. DY Lee in his 1978 "Laboratory Study of Slurry Seal Coats" recommends as a 20% reduction in film thickness from 8 um to 6.5 um which will partially compensate for excess bitumen due to CKE addition. In the stockpiles.

2. In the stockpiles, there is normally twice as much moisture in the 0/#16 fraction as in the +#16 fraction. (see Benedict, 1984 and Les Harkness, 1970) CKE values will likely be found to be proportionate to amount of fines present due not only to the large absorbtion area of the fines but also to the resulting capillary action between the fines granules.

3. In Kansas, Bill Ballou reports that cold mix designs by surface area use only 1/3 the actual CKE values to determine bitumen content.

4. Typical surface area analysis places most of the surface area, and the bitumen (80%±) in the fine fraction of the gradation.

5. See Benedict 1989 Kona paper on "Effect of Gradation on Slurry Design Tests".

6. Thanks to Cody Yarborough of ScanRoad, Inc. Waco, for running the reference CKE tests. Report 12/10/90 FX-900.

7. Reference communication to Jim Herriman Pavement Research Center Sacremento, California March 19, 1990.

8. ISSA Technical Bulletin No. 118 "Surface Area Method of Slurry Seal Design".

9. Pablo E. Bolzan, LaPlata, Argentina "Proposed Modified Surface Area Method for Slurry Seal and Cold Micro-Asphalt Concrete Design" presented ISSA 28th Convention, Tampa, Florida February 1990.

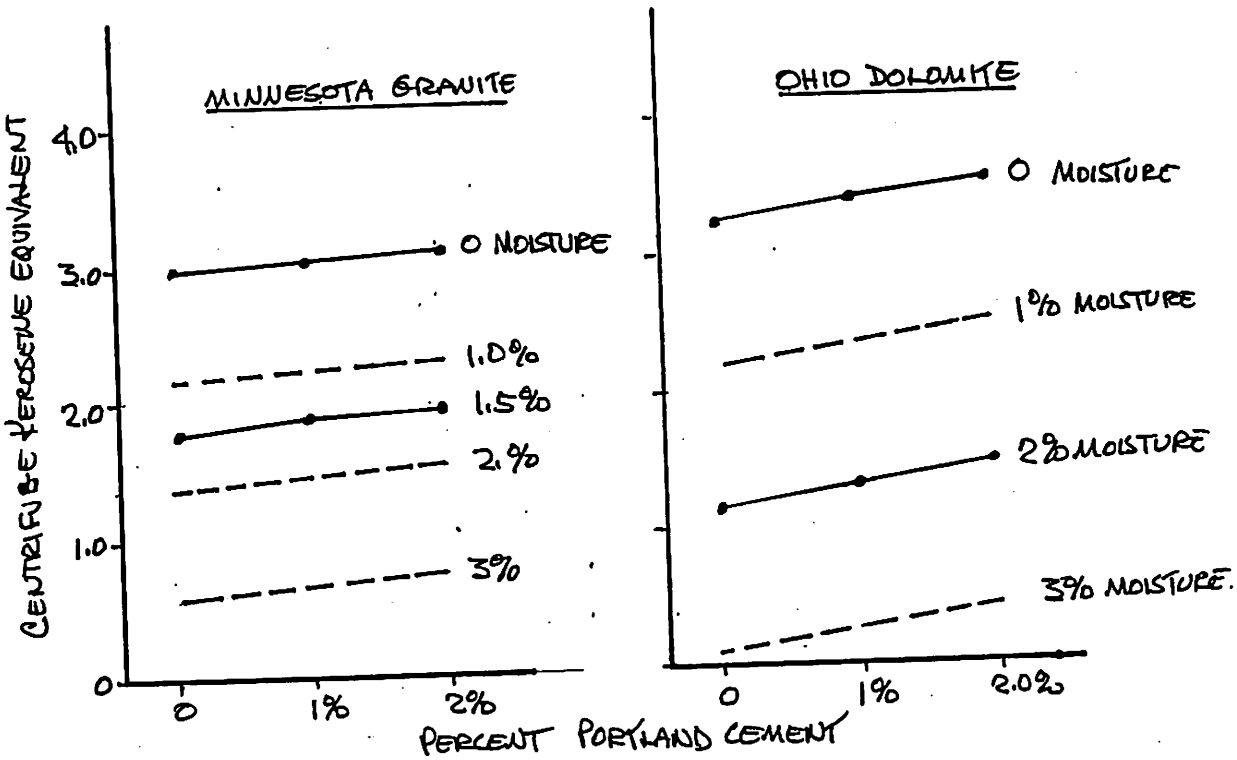

FIGURE 2 CKE- EFFECT OF MOISTURE ON CKE

CRB 1/7/91

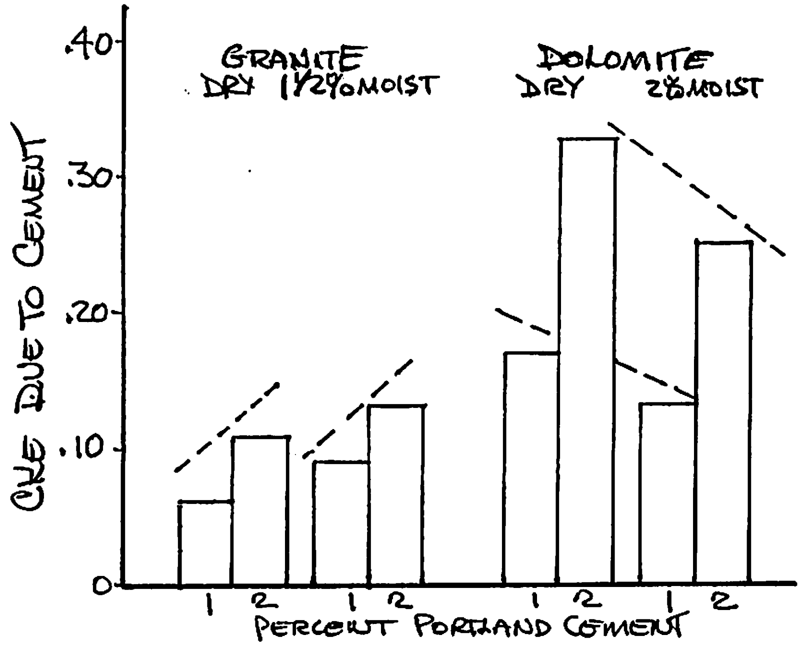

FIGURE 1 EFFECT OF MOISTURE CONTENT & AGGREGATE TYPE ON THE INCREASE IN CKE DUE TO PORTLAND CEMENT

CRB 1/7/91

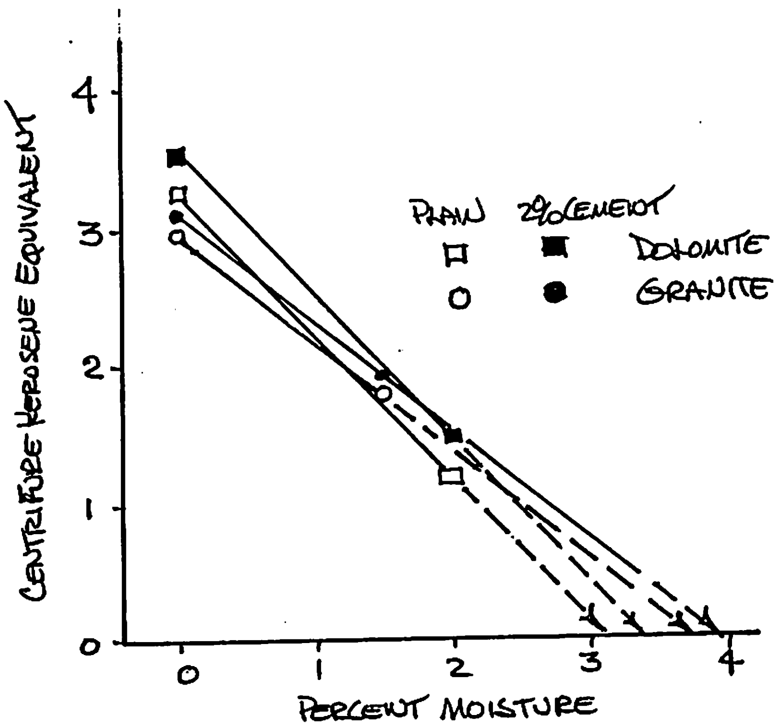

FIGURE 3 PROJECTED <u>ZERO</u> CKE

CRB 1/7/91

7. Reference communication to Jim Herriman Pavement Research Center Sacremento, California March 19, 1990.

8. ISSA Technical Bulletin No. 118 "Surface Area Method of Slurry Seal Design".

9. Pablo E. Bolzan, LaPlata, Argentina "Proposed Modified Surface Area Method for Slurry Seal and Cold Micro-Asphalt Concrete Design" presented ISSA 28th Convention, Tampa, Florida February 1990.

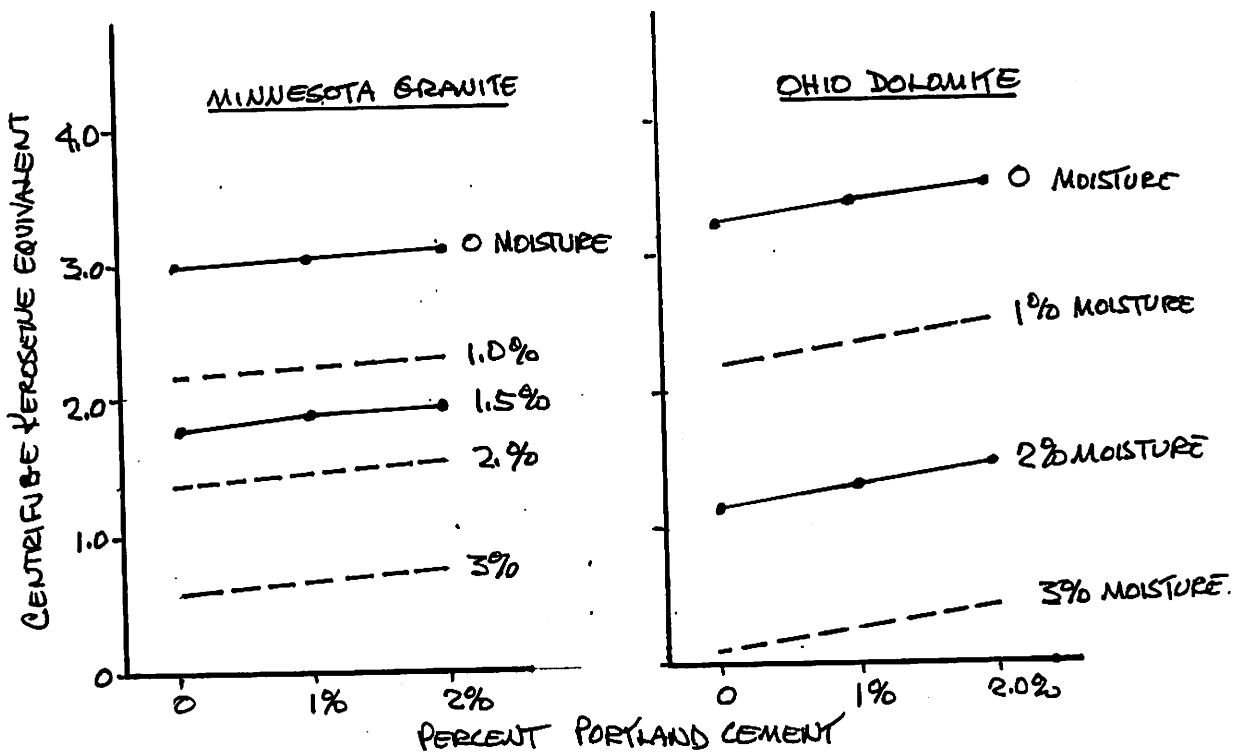

FIGURE 2 CKE- EFFECT OF MOISTURE ON CKE

CRB 1/7/91

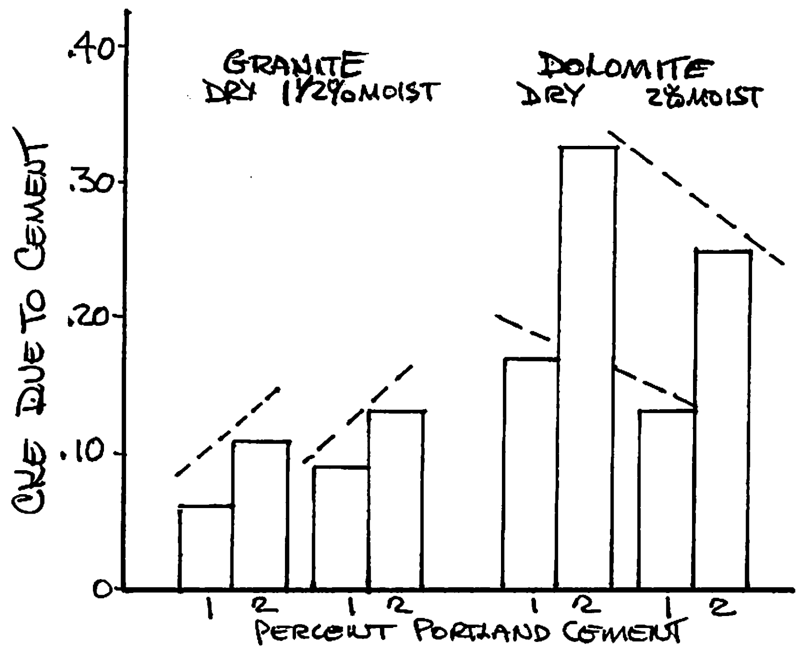

FIGURE 1 EFFECT OF MOISTURE CONTENT & AGGREGATE TYPE ON THE INCREASE IN CKE DUE TO PORTLAND CEMENT

CRB 1/7/91

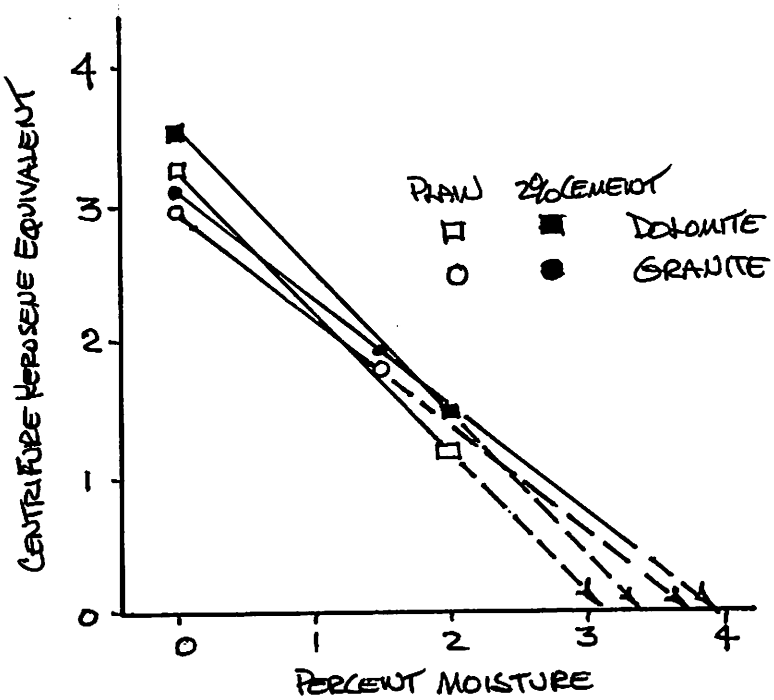

FIGURE 3 PROJECTED ZERO CKE

CRB 1/7/91