MEASUREMENT AND CONTROL OF CONSISTENCY IN SLURRY SEALS

By

C. Robert Benedict
BENEDICT SLURRY SEAL, Inc.
320 Northview Road
Dayton, Ohio
45419

An annotated summary report for presentation to the Research & Development Committee meeting held at the Mariott Inn, Kansas City, Mo. October 28, 1975

Material presented for comment and inclusion in the forthcoming International Slurry Seal Association's Technical Bulletin Nr. 106.

---

1. Indiscriminate use of water during the mixing and application of slurry seal can affect the appearance and durability of slurry seal. Optimum mix water and pre-wet spray bar water[a] will result in superior appearance and performance. Excessive water can destroy an otherwise properly designed and applied slurry resulting in a non-uniform, greasy appearance with wet and sloppy seams, marred gutter plates and curbs, sloppy terminations and intersection lines, intersection scrub-off, increased aggregate kick-off and loss and decreased durability.

2. "Smooth," "Creamy," "Homogeneous," "Uniform," "Stable," "Non-Segregating," "Non-Draining," and "Fluid" are terms that have been used to describe a satisfactory consistency of slurry.

3. Four methods to <u>measure</u> the mix consistency are:
   1) The ISSA WTAT Funnel Flow Test[1]
   2) The Young Consistency Test[2] (inclined plane)
   3) The Fiock Stick Test[3]
   4) The Kansas Cone Consistency Test

4) The first three tests, though useful, are somewhat qualitative and subjective. The Kansas Cone Consistency Test gives a Numerical Value to slurry consistency that is useful in laboratory design and field control by operators and inspectors. This test is now used by the Kansas and California DOT's and the U. S. Corps of Engineers, Vicksburg [4].

5) The Kansas procedure is quoted directly from "Laboratory Procedure for Slurry Design Followed by the Kansas Highway Commission", section B, paragraph 4. (Undated, received from Bud Clovis, August 2, 1974)

"Consistency Tests are performed by using a cone, specified for the dry condition of fine aggregates for surface dry specific gravities (AASHO T84) and a 9 x 9 Industrial Tile. The tile has ½ inch concentric circles inscribed in diameters greater than the large end of the cone. Several mixes are made using 400 grams of combined aggregate from the dried sample portion, filler (1½%, more if aggr. is low in -200 mesh), the emulsion in the quantity considered optimum and with varied additional moisture of water contents. The cone is filled loosely and struck off in place on the center of the tile The cone is removed and the flow on the tile is determined. Some mixes will slump but not flow, therefore, mixes with variable moisture contents are run until a moisture content can be determined which will give a one inch flow on the tile. This method has been proven to give a workable mix for slurry sealing, but it must be done with the emulsion grade to be used on the project to prove successful in all instances."

Note (a) Spray bar water as recommended in ISSA Guide Specification A 105, June 1975,* states: "Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparant flowing water in front of the slurry box."

Note (1) The ISSA WTAT (Wet Track Abrasion Test) Funnel Flow Test *, Section 2.6 and 3.3.3 measures the ability of a slurry to flow through the ½ inch opening of a 6 or 7 inch funnel. The lowest water content slurry which will flow through the funnel is taken as optimum. Mixtures which are "too wet" are therefore segregate will not flow through the funnel. Mixtures that are "too dry" or stiff also will not flow through the funnel.

Note (2) The Young Consistency Test** measures the flow of a 3¾ cubic inch freshly prepared slurry down a 30° inclined glass plate. A flow of up to 6½ inches is considered satisfactory.

Note (3) The Fiock Stick Test** states "...draw a solid object (such as a stick) through a sample of the mixture.... If the resulting depression persists more or less indefinitely, the slurry is stable. On the other hand, if such a depression fills quickly with the liquids present, leaving a smooth horizontal surface, the surface tested is not a slurry and should not be applied."

Note (4) see: U. S. Corps of Engineers, Vicksburg
Instruction Report S-75-1
"Slurry Seal Surface Treatments"
by Lenford N. Godwin
June 19, 1975
Library of Congress Card # TA 7.434i - no. S-75-1

* The ISSA Wet Track Abrasion Test and Guide Specification nr. A105, June, 1975 are both available from ISSA headquarters Drawer "F", St. Louis, Missouri 63044 (314-739-1237)

** The Young and Fiock Tests are reported in the paper: "Laboratory Experience with Asphalt Slurries and Their Constituents" by Dr. E. F. Fiock presented and published in the Proceedings of the 7th Annual ISSA Convention, Jan. 8-10, 1969, Miami, Florida.

6. Comments and Tentative Recommendations for discussion and action by the ISSA R & D Committee:

a) The Kansas Cone Consistency Test gives a Numerical Value to the consistency of slurry which can be applied internationally. We recommend adoption tentatively into our specificatinns.

b) In field practice, a commonly available coffee cup, the "Solo 7-Oz. #870 Cosy Cup" with the bottom removed may conveniently substitute for the brass cone specified in the Kansas Test.

c) Included here is a metric flow scale. Both Metric Scale and English Scales should be made available from the ISSA office.

d) We recommend the adoption of the metric scale as standard.

e) Care should be taken to cast quick-set slurries at a standard mix time such as 30 seconds after introduct of the AE.

f) After the cast is made on the flow scale, the flow should be measured at four points 90^{0} apart , averaged and recorded.

g) Reproducibility should be $\pm$ .25 centimeters.

h) Optimum is tentatively considered to be 2.5 centimeters flow.

i) Tentative limits of from 2.0 to 3.0 cm. is recommended.

j) Job materials should be used in the design of optimum water content. Changes in filler quantity, Asphalt Emulsion or aggregate gradation of $\pm$ 3% requires re-design for water content.

k) Internal or absorbed moisture of the aggregate should be studied in the laboratory to allow for field variations.

l) Increases in field temperature will likely require more mix water to matain the same flow measurements at lab temperatures and should be studied.

m) In one experimental series, the flow/water curve was found to be nearly linear and a 1% increase in mix water caused an approximate flow increase of one centimeter. (see graph on pg.5)

n) Within the recommended limits of 2.0 to 3.0 cm., an overall variation of 1½% mix water is permissable in this experimental series. This translates to field control of quantities to 3.6 gallons of water per ton or 36 gallons per 10-ton load.

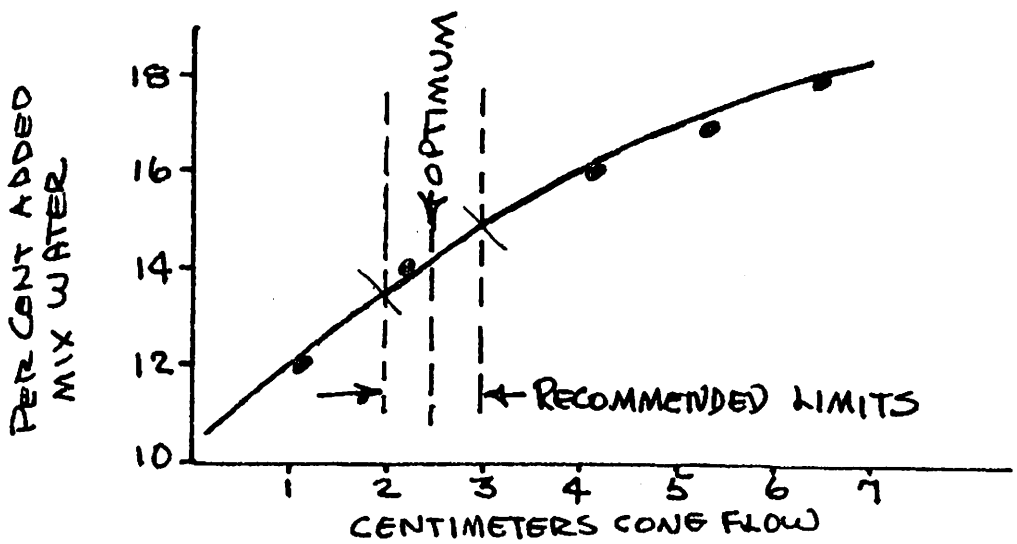
o) A field control chart is included on page 5 so that the percentage of added mix water can be determined by the inspector and operator by making appropriate adjustments for moisture content of the aggregate and the amount of water used for dampening the surface.

CHART FOR FIELD DETERMINATION OF MIX WATER ADDED TO SLURRY MIXES

% WATER ADDED	GALS. PER TON	% WATER ADDED	GALS PER TON	% WATER ADDED	GALS PER TON	% WATER ADDED	GALS. PER TON
1	2.4	6	14.4	11	26.4	16	38.4
2	4.8	7	16.8	12	28.8	17	40.8
3	7.2	8	19.2	13	31.2	18	43.2
4	9.6	9	21.6	14	33.6	19	45.6
5	12.0	10	24.0	15	36.0	20	48.0

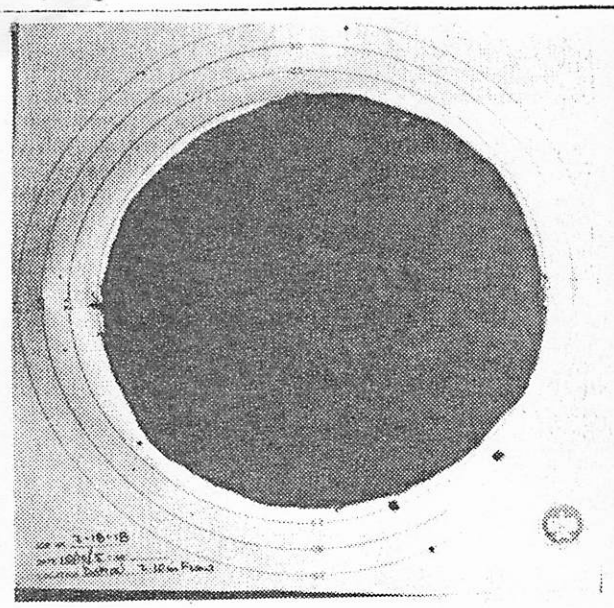
NOTE: CALCULATIONS ARE BASED ON WATER @ 8.4 LBS/GAL. DEDUCTIONS FROM DESIGN WATER% SHOULD BE MADE FOR MOISTURE IN THE AGGREGATE AND PRE-WET SPRAY BAR WATER OF .0% to .07 GALLON PER S.Y., TYPICALLY 80 to 90 GALLONS PER 10-TON LOAD.

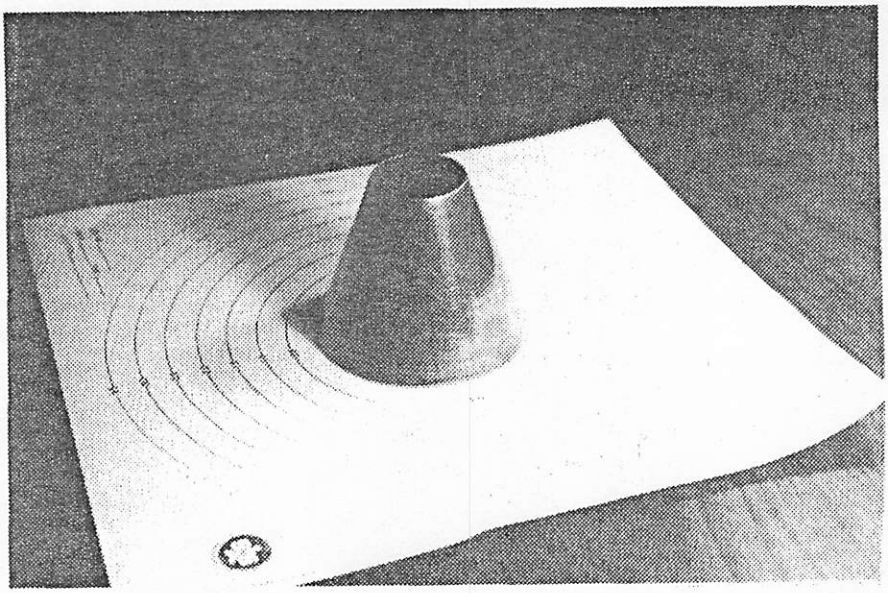
20

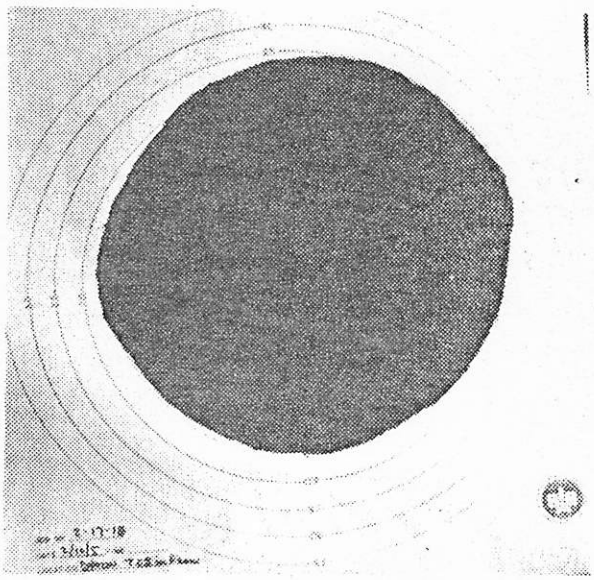


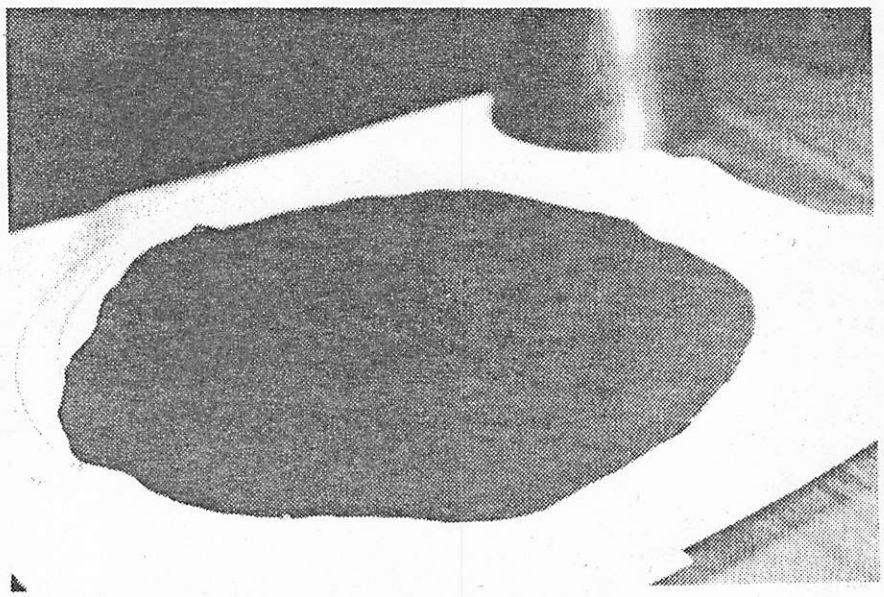
ADDED WATER VS. CONE FLOW
(BLACKAT & XENIA TYPE II)

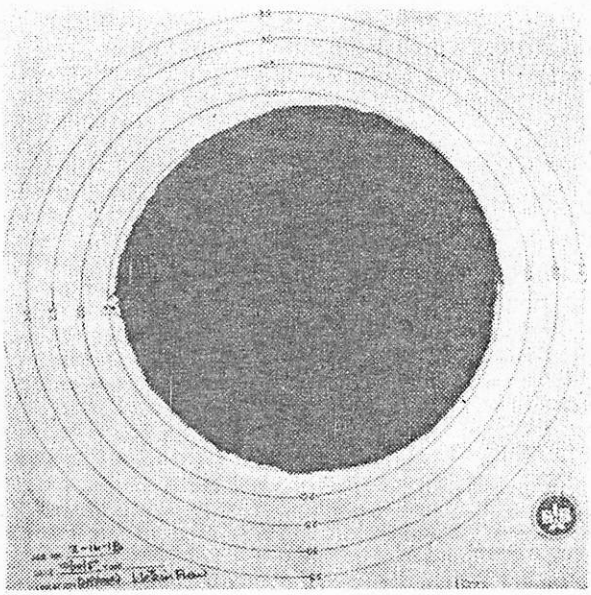
NOTE: THIS SET OF LABORATORY CURVES INDICATES AN OVERALL TOLERANCE OF 1½% MOISTURE OR 36 GAL/10 TONS.

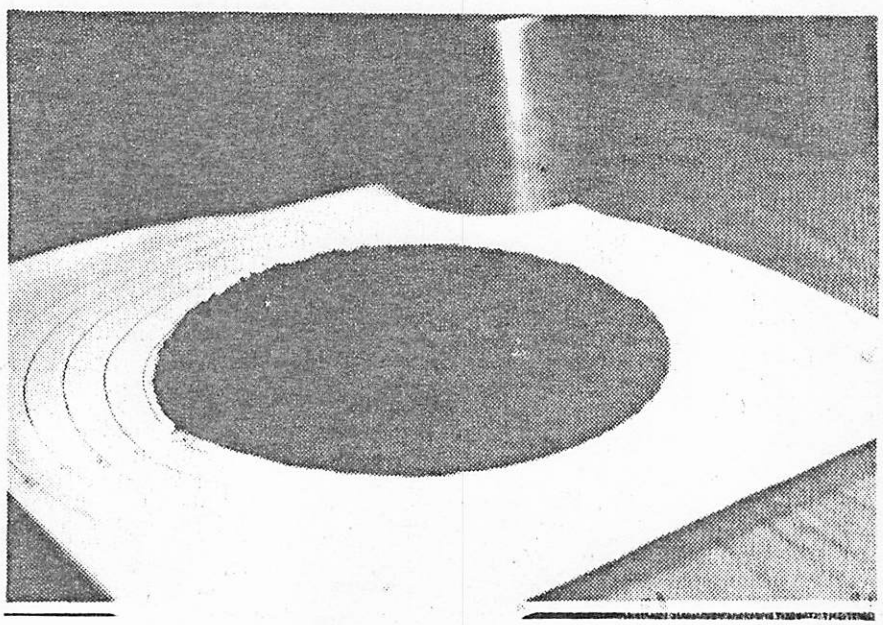




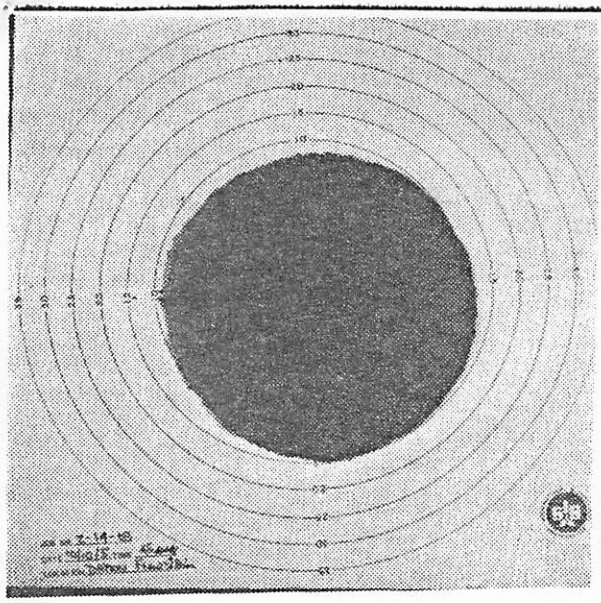


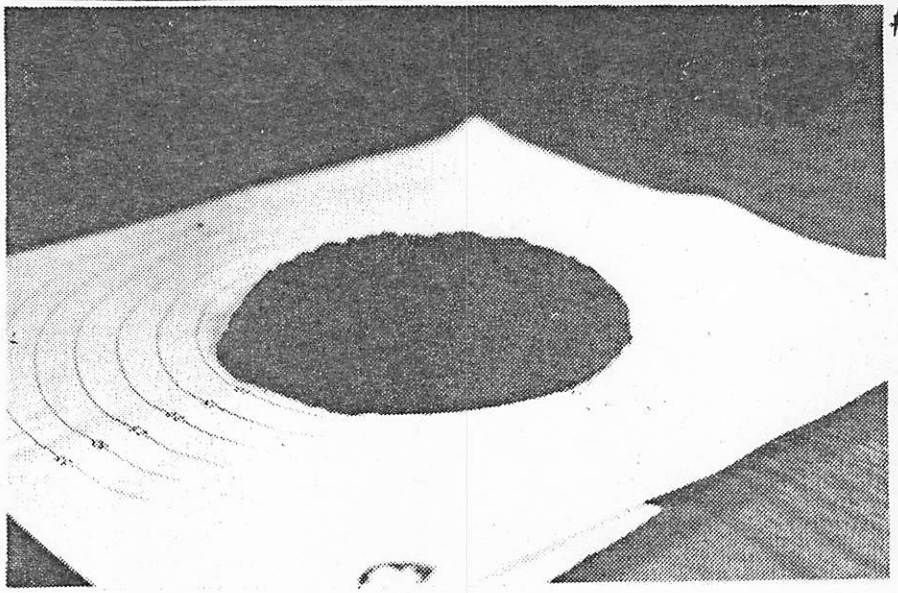




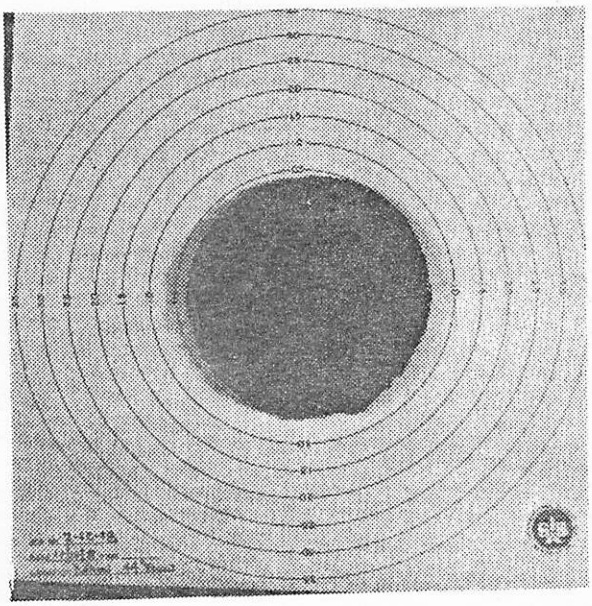


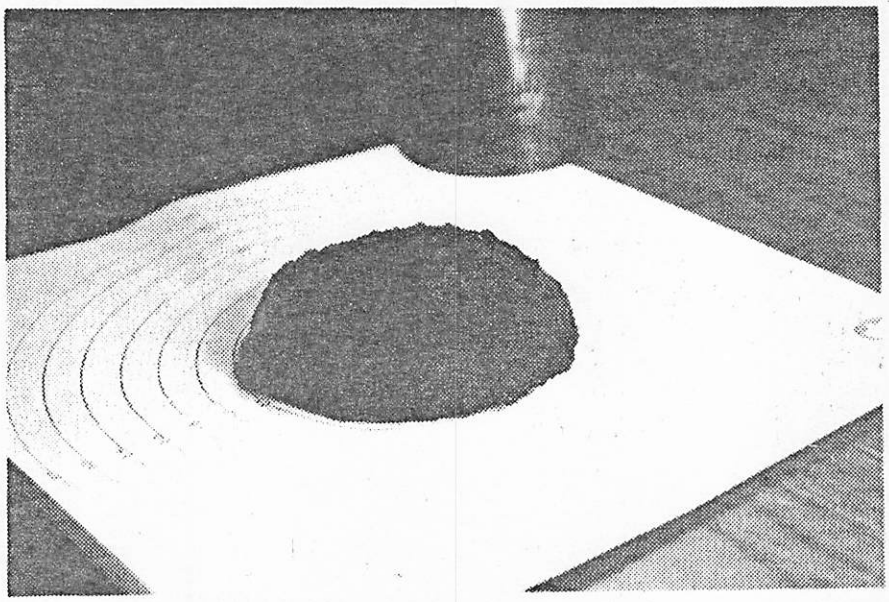
ISSA TECH BUL. Nr. 106 - EFFECT OF 18%, 17%, 16%, 14%, 12% & 10%

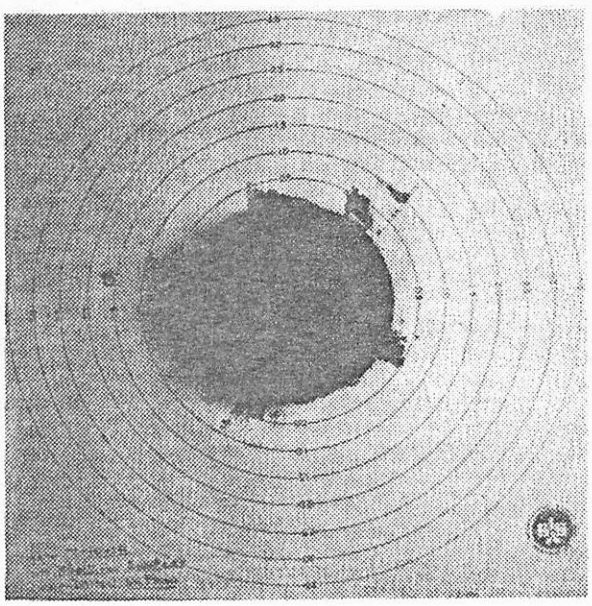


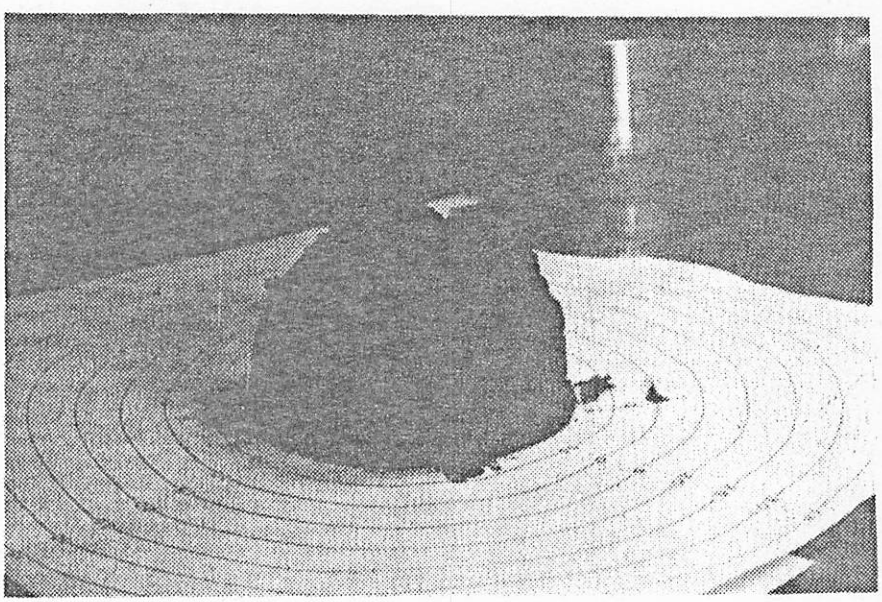


*

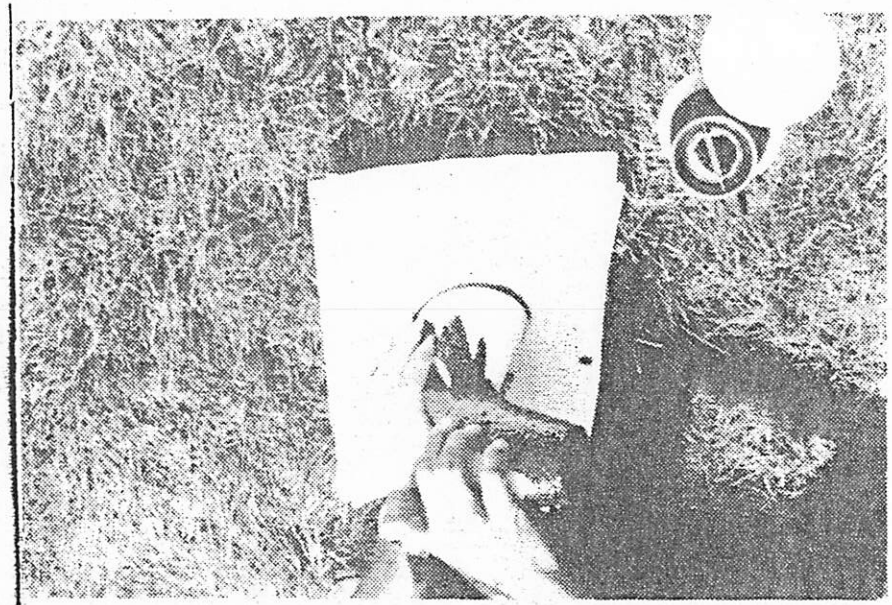


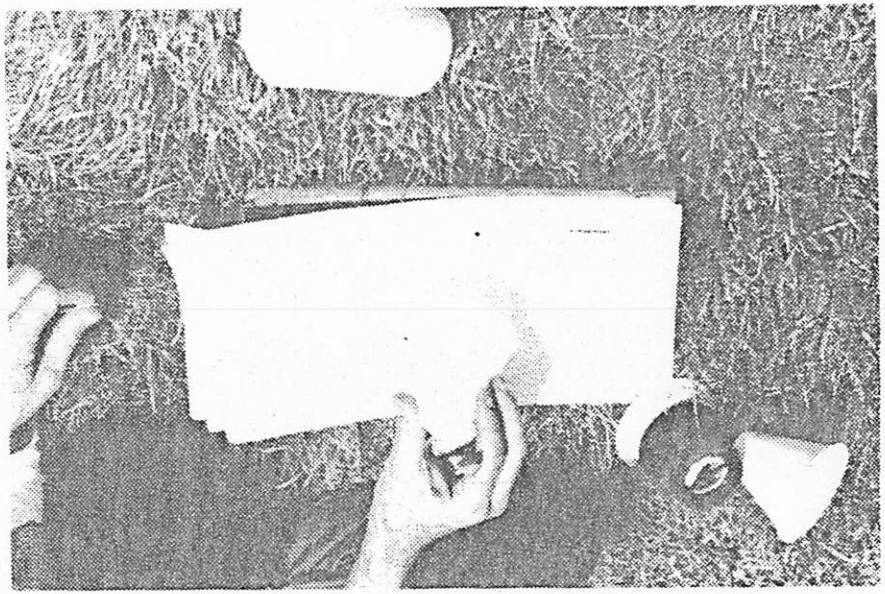


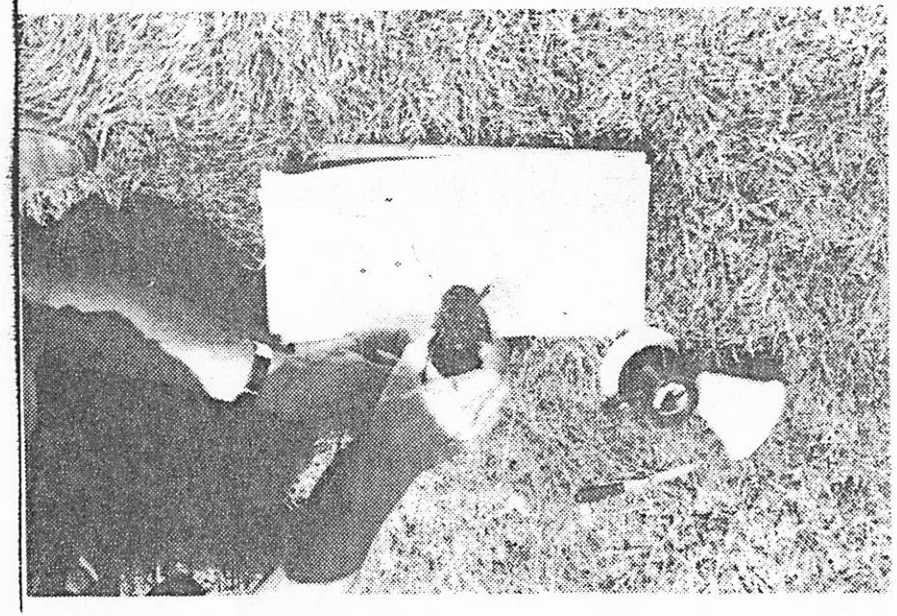


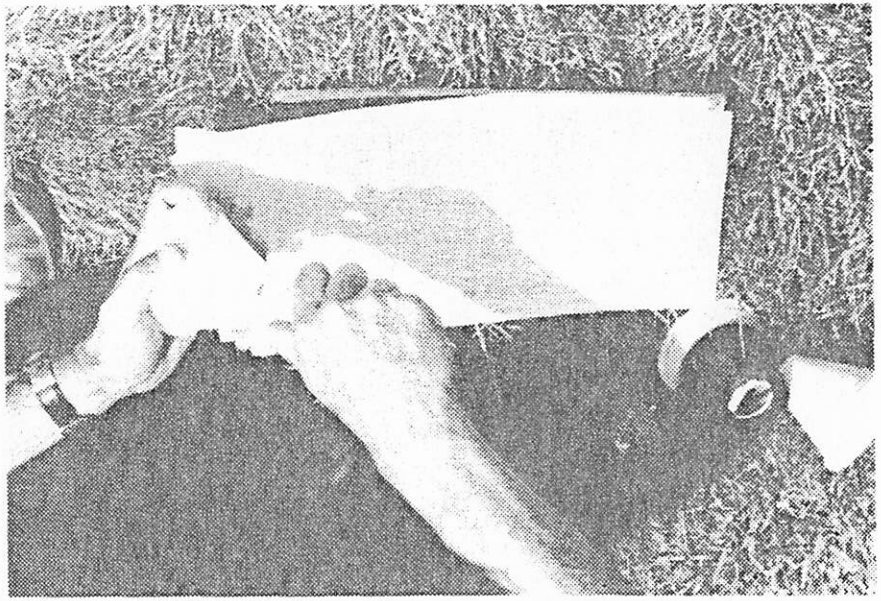


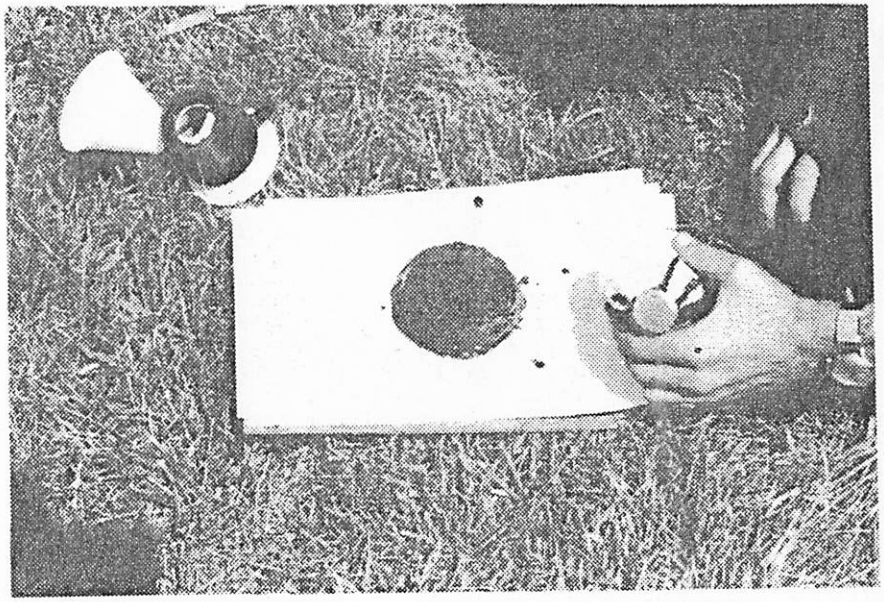
MIX WATER ON ONE SYSTEM • CONE CONSISTENCY @ 14% IS OPTIMUM*

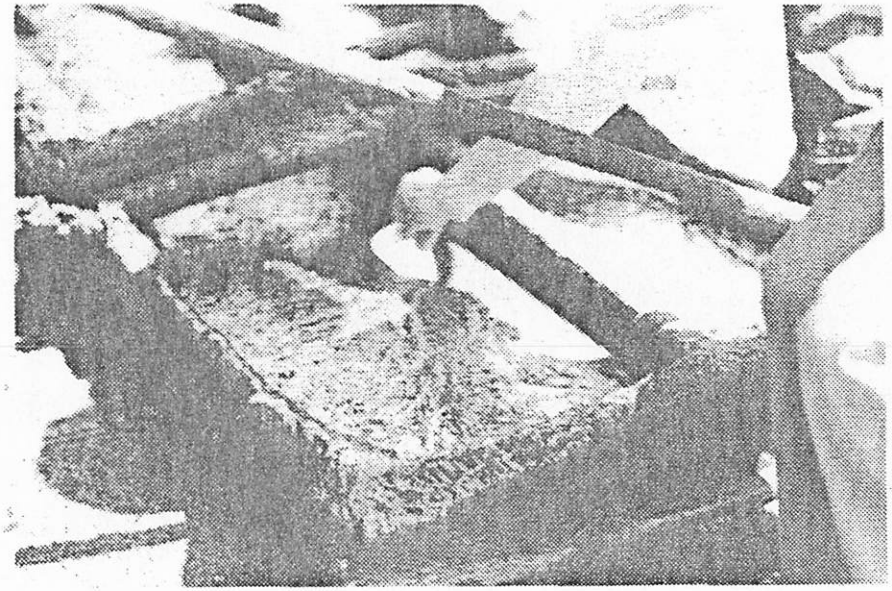


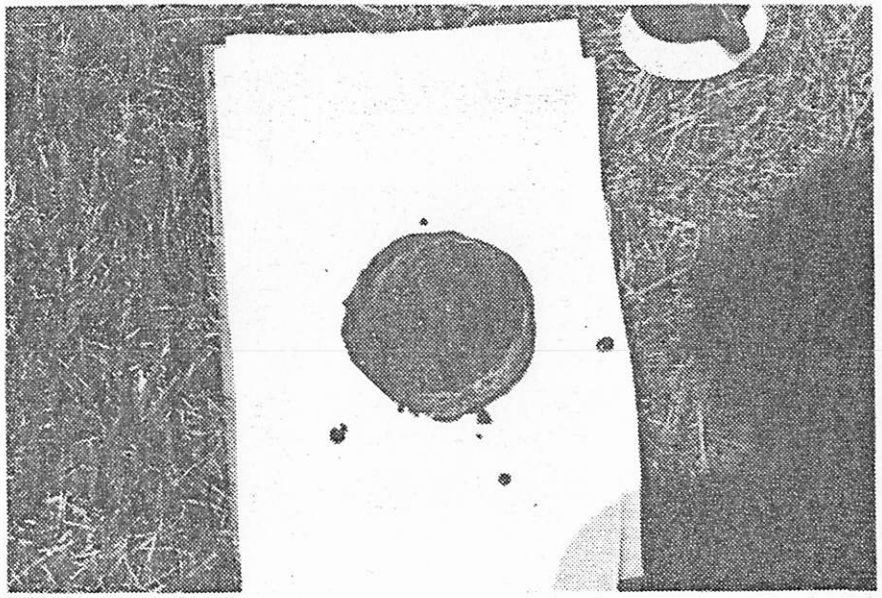




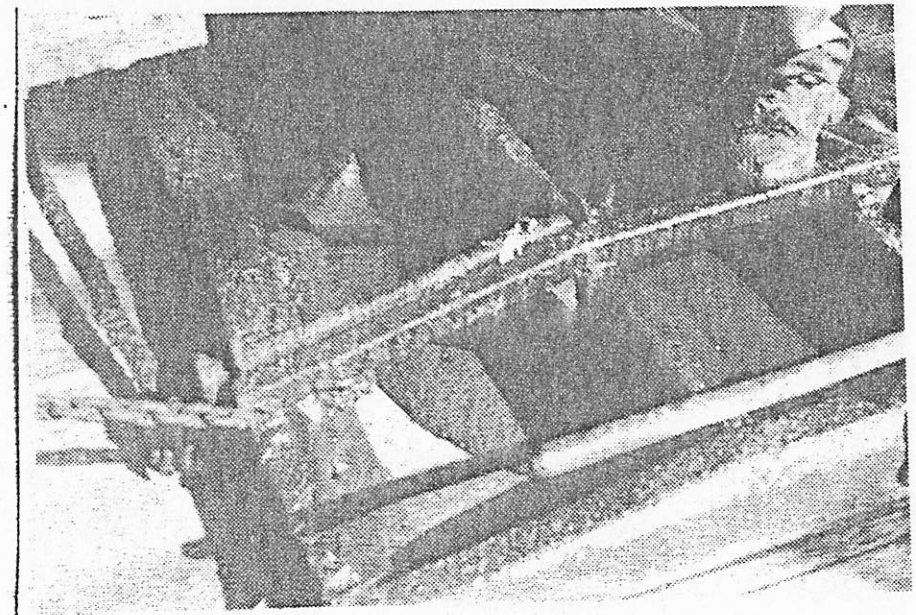


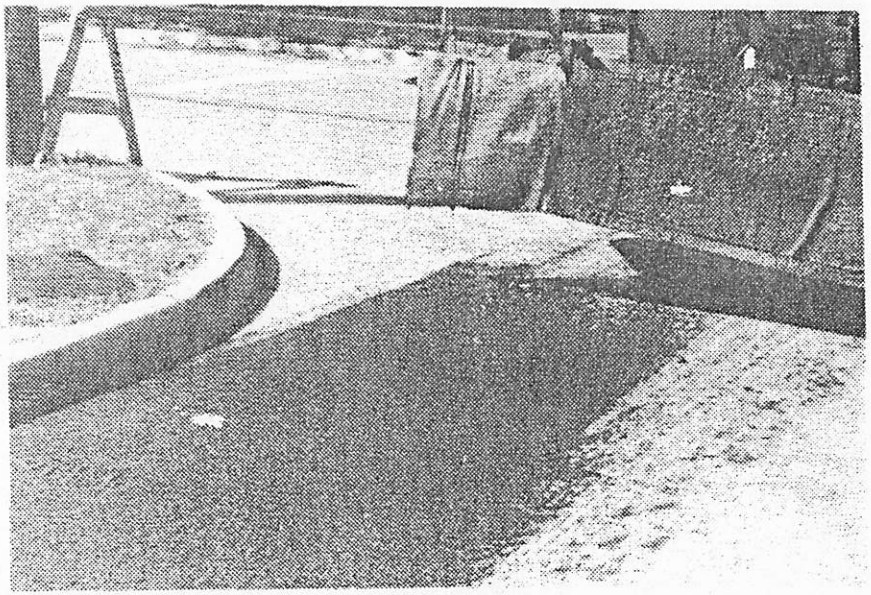


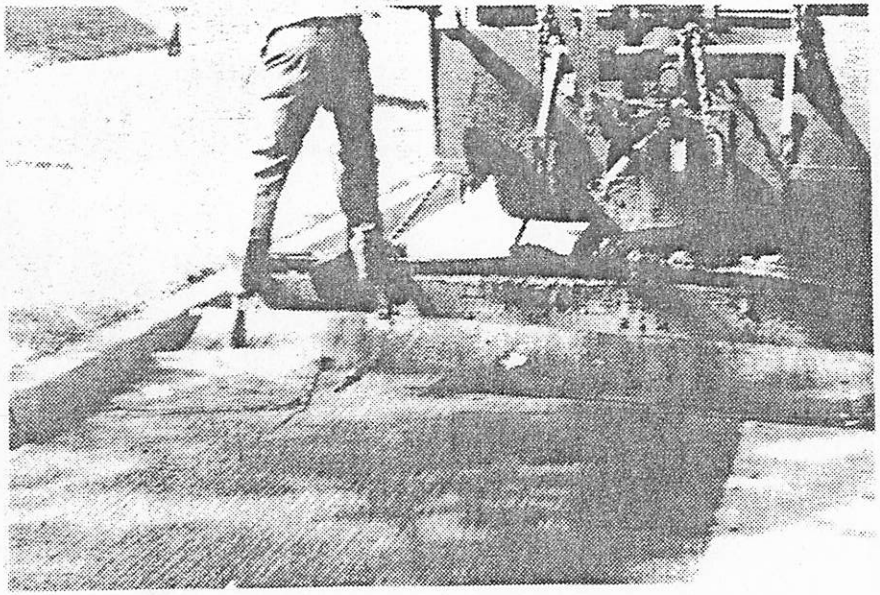


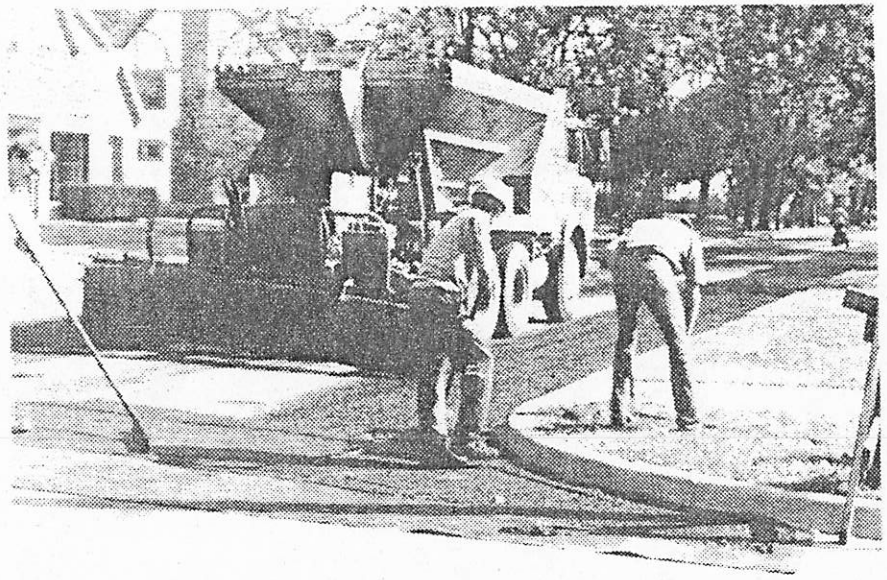


FIELD TEST OF SLURRY CONSISTENCY USING KANSAS CONE TEST
INTERNATIONAL SLURRY SEAL ASSOCIATION TECHNICAL BULLETIN NO. 106

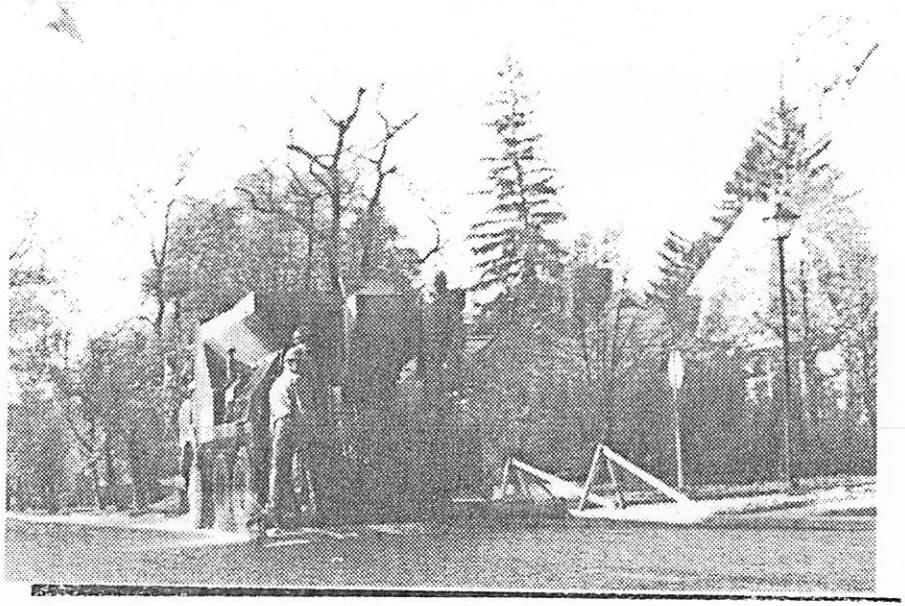








PROPER CONTROL OF MIX & PRE-WET WATER TO DESIGN CONSISTENCY, SHOWN HERE AT 3 CM. KANSAS CONE FLOW, MAKES A WORKABLE MIX. NOTE THE HOMOGENEOUS APPEARANCE OF THE SLURRY "ROLLING" IN THE BOX.



NOTE THE DRY TERMINATION, EASE OF HAND WORK, THE CLEAN-CUT STRAIGHT LINES, CLEAN CURBS & NEARLY FAULTLESS JOINTS. NOTE ALSO HOW THE PAPER FACILITATES A NEAT INTERSECTION LINE. ISSA TECH. BUL. 106

INTERNATIONAL SLURRY SEAL ASSOCIATION