(OUTLINE DRAFT-NOT FOR PUBLICATION)

"TOWARDS A RATIONAL MIX DESIGN TECHNIQUE FOR THIN LAYERED COLD MIXES & SLURRY SEAL"

OUTLINE OF A REPORT PRESENTED BY C. ROBERT BENEDICT TO THE ISSA RESEARCH COMMITTEE MEETING FEBRUARY 13, 1984; MAUI, HAWAII

I. REVIEW OF DESIGN TECHNICAL BULLETINS-1984

II. OBJECTIVES OF THIN LAYERED COLD MIX DESIGN IS TO PROVIDE

A SURFACE WHICH IS: OR:

A SURFACE WHICH IS:	OR:
-DURABLE	-ACCEPTABLE
-SAFE	-EFFECTIVE
-ECONOMICAL	-AFFORDABLE

CONTRACTORS OBJECTIVES ARE: HOW TO MIX & LAY A JOB THAT:

THE CUSTOMER WILL PAY FOR
THE CUSTOMER WILL REPEAT

III. EMULSION MIXES, PARTICULARLY THIN-LAYERED SURFACE MIXES, EXPONENTIALLY MAGNIFY THE PROBLEMS OF THICK LAYERED COLD MIXES AND HOT MIXES; PROBLEMS WHICH, IN THICKER LAYERS, MAY TAKE MUCH LONGER TO APPEAR THAN IN THINNER LAYERS.

DENSE-GRADED EMULSION MIXES ARE USUALLY MULTI-COMPONENT SYSTEMS WHICH MUST DEAL WITH THE EFFECTS OF THE PRESENCE OF WATER, WHERE HOT MIXES DEAL ONLY WITH DRY AGREGATE AND A THERMOPLASTIC BINDER.

WITH EMULSION MIXES THE VARIABLES TO DEALT WITH ARE LEGION; E.G.,

1. 32 VARIABLES FOR SPREAD RATES
2. 28 VARIABLES FOR DEVELOPMENT OF COHESIVE STRENGTH
3. 26 VARIABLES FOR EMULSION MANUFACTURING

TO EXAMINE ALL OF THE LITERALLY MILLIONS OF POSSIBLE COMBINATIONS IN THE DESIGN OF THIN LAYERED EMULSION MIXES IS IMPOSSIBLE.

A MORE PRACTICAL APPROACH IS NECESSARY; i.e. TO CONSTRUCT A REPRESENTATIVE RANGE OF LABORATORY SPECIMENS, SUBJECT THE SPECIMENS TO MEANINGFUL LABORATORY TESTS WHICH ARE RELATED TO FIELD PERFORMANCE. THE DESIGNER THEN CONSIDERS THE OBJECTIVES AND SEEKS ANSWERS TO THESE PERFORMANCE QUESTIONS:

1. WILL "IT" MIX?
2. WILL "IT" SET?
3. WILL "IT" LAST?
4. WILL "IT" BE SAFE?
5. WILL "IT" SEAL?

NOTE: SPECIFICATIONS FOR AGGREGATES AND EMULSIONS ARE NOT PERFORMANCE OR FUNCTIONALLY ORIENTED. NOTHING IS SAID, E.G., ABOUT THE EMULSION BEING CAPABLE OF STICKING 2 STONES TOGETHER, WE MUST LOOK AT THE <u>PERFORMANCE</u> OF THE TOTAL MIX SYSTEM-

IV. ISSA's RESEARCH EFFORTS ARE DIRECTED TOWARDS ANSWERING THESE FUNCTIONAL & PERFORMANCE QUESTIONS

1. <u>WILL "IT" MIX?</u>
   a) ISSA TECHNICAL BULLETIN #113 TRIAL MIX PROCEDURE
   b) TB#106 CONSISTENCY/SEGREGATION
   c) TB#114 WET STRIPPING TEST (ADHESION)
   d) TB#115 COMPATIBILITY
   e) TB's 116,117,139 SPECIFICATIONS FOR SS, QS, QT SYSTEMS

   <u>RESEARCH:</u>

   A STRIP-CHART MIXING CHARACTERISTICS METHOD TO AID IN CONTROLLING EMULSION MIXING QUALITIES <u>BEFORE</u> SHIPMENT AND AS A FORMULATION AID. ALSO TO DETERMINE FIELD MIXER REQUIREMENTS.

2. <u>WILL "IT" SET?</u> (AND CURE)
   a) TB#102 BLOTTER/WATER RESISTANCE TESTS
   b) TB#139 SYSTEM CLASSIFICATION BY COHESION TESTER (CT)
   c) ASTM D3910.80a COHESION TEST

4. <u>WILL "IT" BE SAFE?</u>

(a) TB#109 LOADED WHEEL TEST (LWT) AND EXCESS AC BY SAND ADHESION. RATE OF COMPACTION BY LWT TACKINESS POINT BY LWT.

(b) TB#141 MACRO TEXTURE RESEARCH BY ORDEMIR; ISSA/ISU RESEARCH PROGRAM

(c) TB#112 FIELD MACRO TEXTURE MEASUREMENT

RESEARCH:

DESIGN PROCEDURE FOR SPECIFIC MACROTEXTURE AT VARIOUS LAYER THICKNESSES. SIMPLER METHOD OF BLANK SAND ADHESION BY CT. COMPRESSION RATE/RESISTANCE TO COMPACTION. EFFECT OF TEMPERATURE STABILITY(R&B SOFTENING POINTS) EFFECT FINES & FINES QUALITY ON COMPACTION RATES & TEMPERATURE SUSCEPTABILITY. KANDHAL & ANDERSON'S WORK ON BAGHOUSE FINES. MASTIC THEORY.

5. <u>WILL "IT" SEAL?</u>

(a) NO ISSA TEST METHODS YET.

RESEARCH:

HERRIMAN'S WORK IN CALIFORNIA REPORTED IN GUADALAHARA; LWT PERMEAMETER/CRB FOR COMPACTED & UNCOMPACTED SPECIMENS; FIELD RESEARCH ON PAIRED SEALED & UNSEALED PAVEMENTS (MEASUREMENT ON RATE OF DUCTILITY LOSS); THE KANDHAL CURVE AND SLURRY'S EFFECT.

V. SIMPLIFICATION OF DESIGN PROCEDURES

1. PRESENT DESIGN METHOD INCLUDES

a) COMPATIBILITY
b) DETERMINE MINIMUM AC-WTAT
c) DETERMINE MAXIMUM AC-LWT
d) SELECT FIELD TOLERANCES AND OPTIMUM DESIGN

2. PRESENT DESIGN METHOD REQUIRES ABOUT 45 HOURS LAB TIME AT $48.00/HOUR CURRENT LAB RATES THE COST IS $2160.

RESEARCH:

(a) WET COHESION TESTER ISSA-AEMA STUDY, EFFECTS OF DIFFERENT WATER, CEMENTS, EMULSIFIER SYSTEMS, AGGREGATES: SPIN TORQUE INDENTIFICATION; FRICTIONLESS TURN TABLE AND MOTORIZED DRIVE WITH RECORDING, BENEDICT & DUNNING STUDY

b) DRY COHESION TEST DEVELOPMENT, PUNCH TEST TO MEASURE COHESIVE STRENGTH-STRETCH AND LONG-TERM RATE OF CURE. MINI HUBBARD-FIELD TEST, MINI HVEEM COHESIOMETER

c) WET AND DRY EFFECTS OF ENVIRONMENT AND LOW-TEMPERATURE COALESCENCE STUDIES

3. WILL "IT" LAST?

(a) TB#100, WET RACK ABRASION TEST(WTAT) PRIMARILY MEASURES "MAT" COHESION AND TO A LESSER EXTENT, ADHESION DETERMINES MINIMUM CONTENTS ONLY. 20th ANNIVERSARY OF KARI & COYNES' AAPT PAPER; ADOPTED BY ISSA IN 1967

(b) TB#136 CAUSES OF WTAT INCONSISTENCIES

(c) TB#114 WET STRIPPING TEST

(d) TB#123 AGGREGATE QUALITY AND GRADATION BY SHAKER WEAR TEST(SWT)

RESEARCH:

EFFECT OF LAYER THICKNESS; POSSIBLE TO USE 100%--#4 AND ADD FOR +4 BY SURFACE AREA RATIO; WET STRIPPING TEST CONFIRMATION BY KENNEDY AT AUSTIN; PROBLEM USING WTAT TO ESTABLISH MAX AC.; WTAT, WITH POOR ADHESION-COHESION YIELDS EXCESS AC.; AEMA's 40 GRAM LOSS RECOMMENDED VALUE'S QUESTIONED; SOME SYSTEMS READ 5 WHILE OTHERS READ 200 AT THE SAME %AE!

3. OTHER METHODS CONSIDERED:

a) YOUNG RUBBER DOUGHNUT WTAT
b) SURFACE AREA & CKE FOR 8 & 6.5mm COATINGS
c) CALIFORNIA OR KANSAS SHAKER
d) IOWA GILSON SHAKER
e) VOIDS ANALYSIS, % FILLED AT VARIOUS COMPACTION LEVELS PERMEABILITY, ADHESION, COHESIVE STRENGTH, MACROTEXTURE, AND GRADATION LAYER THICKNESS RANGE.
f) A COMBINATION PROCEDURE OR TOOL WHICH MEASURES

a) WORKABILITY
b) SETABILITY
c) STICKABLITY
d) SAFENESS-ABILITY
e) SEALABILITY

4. FINALLY ANY METHOD USED MUST CONSIDER THE LAB-FIELD <u>PERFORMANCE</u> OF THE <u>MIX</u>; NOT THE INDIVIDUAL MATERIALS.

FROM THE MANY NOTIONS PRESENTED HERE, I THINK YOU'LL AGREE THAT MUCH MORE IS TO BE LEARNED AND THAT THERE IS NO NEED TO WORRY ABOUT, RUNNING OUT OF IDEAS FOR OUR COMMITTEE'S WORK!

WE INVITE YOUR COMMENTS AND OPINIONS TOWARDS DEVELOPING A SIMPLIFIED & MORE RATIONAL APPROACH TO DESIGN FOR THIN LAYERED COLD MIXES & SLURRY SEALS.

THANKS.

(OUTLINE DRAFT-NOT FOR PUBLICATION)

"TOWARDS A RATIONAL MIX DESIGN TECHNIQUE FOR THIN LAYERED COLD MIXES & SLURRY SEAL"

OUTLINE OF A REPORT PRESENTED BY C. ROBERT BENEDICT TO THE ISSA RESEARCH COMMITTEE MEETING FEBRUARY 13, 1984; MAUI, HAWAII

I. REVIEW OF DESIGN TECHNICAL BULLETINS-1984

II. OBJECTIVES OF THIN LAYERED COLD MIX DESIGN IS TO PROVIDE

A SURFACE WHICH IS: OR:

-DURABLE	-ACCEPTABLE
-SAFE	-EFFECTIVE
-ECONOMICAL	-AFFORDABLE

CONTRACTORS OBJECTIVES ARE: HOW TO MIX & LAY A JOB THAT:

THE CUSTOMER WILL PAY FOR
THE CUSTOMER WILL REPEAT

III. EMULSION MIXES, PARTICULARLY THIN-LAYERED SURFACE MIXES, EXPONENTIALLY MAGNIFY THE PROBLEMS OF THICK LAYERED COLD MIXES AND HOT MIXES; PROBLEMS WHICH, IN THICKER LAYERS, MAY TAKE MUCH LONGER TO APPEAR THAN IN THINNER LAYERS.

DENSE-GRADED EMULSION MIXES ARE USUALLY MULTI-COMPONENT SYSTEMS WHICH MUST DEAL WITH THE EFFECTS OF THE PRESENCE OF WATER, WHERE HOT MIXES DEAL ONLY WITH DRY AGGREGATE AND A THERMOPLASTIC BINDER.

WITH EMULSION MIXES THE VARIABLES TO be DEALT WITH ARE LEGION; E.G.,

1. 32 VARIABLES FOR SPREAD RATES
2. 28 VARIABLES FOR DEVELOPMENT OF COHESIVE STRENGTH
3. 26 VARIABLES FOR EMULSION MANUFACTURING

TO EXAMINE ALL OF THE LITERALLY MILLIONS OF POSSIBLE COMBINATIONS IN THE DESIGN OF THIN LAYERED EMULSION MIXES IS IMPOSSIBLE.

A MORE PRACTICAL APPROACH IS NECESSARY; i.e. TO CONSTRUCT A REPRESENTATIVE RANGE OF LABORATORY SPECIMENS, SUBJECT THE SPECIMENS TO MEANINGFUL LABORATORY TESTS WHICH ARE RELATED TO FIELD PERFORMANCE. THE DESIGNER THEN CONSIDERS THE OBJECTIVES AND SEEKS ANSWERS TO THESE PERFORMANCE QUESTIONS:

1. WILL "IT" MIX?
2. WILL "IT" SET?
3. WILL "IT" LAST?
4. WILL "IT" BE SAFE?
5. WILL "IT" SEAL?

NOTE: SPECIFICATIONS FOR AGGREGATES AND EMULSIONS ARE NOT PERFORMANCE OR FUNCTIONALLY ORIENTED. NOTHING IS SAID, E.G., ABOUT THE EMULSION BEING CAPABLE OF STICKING 2 STONES TOGETHER, WE MUST LOOK AT THE <u>PERFORMANCE</u> OF THE TOTAL MIX SYSTEM-

IV. ISSA's RESEARCH EFFORTS ARE DIRECTED TOWARDS ANSWERING THESE FUNCTIONAL & PERFORMANCE QUESTIONS

1. <u>WILL "IT" MIX?</u>

   a) ISSA TECHNICAL BULLETIN #113 TRIAL MIX PROCEDURE
   b) TB#106 CONSISTENCY/SEGREGATION
   c) TB#114 WET STRIPPING TEST (ADHESION)
   d) TB#115 COMPATIBILITY
   e) TB's 116,117,139 SPECIFICATIONS FOR SS, QS, QT SYSTEMS

   <u>RESEARCH:</u>

   A STRIP-CHART MIXING CHARACTERISTICS METHOD TO AID IN CONTROLLING EMULSION MIXING QUALITIES <u>BEFORE</u> SHIPMENT AND AS A FORMULATION AID. ALSO TO DETERMINE FIELD MIXER REQUIREMENTS.

2. <u>WILL "IT" SET?</u> (AND CURE)

   a) TB#102 BLOTTER/WATER RESISTANCE TESTS
   b) TB#139 SYSTEM CLASSIFICATION BY COHESION TESTER (CT)
   c) ASTM D3910.80a COHESION TEST

RESEARCH:

(a) WET COHESION TESTER ISSA-AEMA STUDY, EFFECTS OF DIFFERENT WATER, CEMENTS, EMULSIFIER SYSTEMS, AGGREGATES: SPIN TORQUE IDENTIFICATION; FRICTIONLESS TURN TABLE AND MOTORIZED DRIVE WITH RECORDING, BENEDICT & DUNNING STUDY

b) DRY COHESION TEST DEVELOPMENT, PUNCH TEST TO MEASURE COHESIVE STRENGTH-STRETCH AND LONG-TERM RATE OF CURE. MINI HUBBARD-FIELD TEST, MINI HVEEM COHESIOMETER

c) WET AND DRY EFFECTS OF ENVIRONMENT AND LOW-TEMPERATURE COALESCENCE STUDIES

3. WILL "IT" LAST?

(a) TB#100, WET TRACK ABRASION TEST(WTAT) PRIMARILY MEASURES "MAT" COHESION AND TO A LESSER EXTENT, ADHESION. DETERMINES MINIMUM CONTENTS ONLY. 20th ANNIVERSARY OF KARI & COYNES' AAPT PAPER; ADOPTED BY ISSA IN 1967

(b) TB#136 CAUSES OF WTAT INCONSISTENCIES

(c) TB#114 WET STRIPPING TEST

(d) TB#123 AGGREGATE QUALITY AND GRADATION SELECTION BY SHAKER WEAR TEST(SWT)

RESEARCH:

EFFECT OF LAYER THICKNESS; POSSIBLE TO USE 100%--#4 AND ADD FOR +4 BY SURFACE AREA RATIO; WET STRIPPING TEST CONFIRMATION BY KENNEDY AT AUSTIN; PROBLEM USING WTAT TO ESTABLISH MAX AC.; WTAT, WITH POOR ADHESION-COHESION YIELDS EXCESS AC.; AEMA's 40 GRAM LOSS RECOMMENDED VALUE'S QUESTIONED; SOME SYSTEMS READ 5 WHILE OTHERS READ 200 AT THE SAME %AE!

4. <u>WILL "IT" BE SAFE?</u>

(a) TB#109 LOADED WHEEL TEST (LWT) AND EXCESS AC BY SAND ADHESION. RATE OF COMPACTION BY LWT TACKINESS POINT BY LWT.
(b) TB#141 MACRO TEXTURE RESEARCH BY ORDEMIR; ISSA/ISU RESEARCH PROGRAM
(c) TB#112 FIELD MACRO TEXTURE MEASUREMENT

<u>RESEARCH:</u>

DESIGN PROCEDURE FOR SPECIFIC MACROTEXTURE AT VARIOUS LAYER THICKNESSES. SIMPLER METHOD OF BLANK SAND ADHESION BY CT. COMPRESSION RATE/RESISTANCE TO COMPACTION. EFFECT OF TEMPERATURE STABILITY(R&B SOFTENING POINTS) EFFECT FINES & FINES QUALITY ON COMPACTION RATES & TEMPERATURE SUSCEPTABILITY. KANDHAL & ANDERSON'S WORK ON BAGHOUSE FINES. MASTIC THEORY.

5. <u>WILL "IT" SEAL?</u>

(a) NO ISSA TEST METHODS YET.

<u>RESEARCH:</u>

HERRIMAN'S WORK IN CALIFORNIA REPORTED IN GUADALAHARA; LWT PERMEAMETER/CRB FOR COMPACTED & UNCOMPACTED SPECIMENS; FIELD RESEARCH ON PAIRED SEALED & UNSEALED PAVEMENTS (MEASUREMENT ON RATE OF DUCTILITY LOSS); THE KANDHAL CURVE AND SLURRY'S EFFECT.

V. <u>SIMPLIFICATION OF DESIGN PROCEDURES</u>

1. PRESENT DESIGN METHOD INCLUDES

a) COMPATIBILITY
b) DETERMINE MINIMUM AC-WTAT
c) DETERMINE MAXIMUM AC-LWT
d) SELECT FIELD TOLERANCES AND OPTIMUM DESIGN

2. PRESENT DESIGN METHOD REQUIRES ABOUT 45 HOURS LAB TIME AT $48.00/HOUR CURRENT LAB RATES THE COST IS $2160.

3. OTHER METHODS CONSIDERED:

- a) YOUNG RUBBER DOUGHNUT WTAT
- b) SURFACE AREA & CKE FOR 8 & 6.5mm COATINGS
- c) CALIFORNIA OR KANSAS OR FLOCK SHAKER
- d) IOWA GILSON SHAKER
- e) VOIDS ANALYSIS, % FILLED AT VARIOUS COMPACTION LEVELS PERMEABILITY, ADHESION, COHESIVE STRENGTH, MACROTEXTURE, AND GRADATION LAYER THICKNESS RANGE.
- f) A COMBINATION PROCEDURE OR TOOL WHICH MEASURES

  - a) WORKABILITY
  - b) SETABILITY
  - c) STICKABLITY
  - d) SAFETY ABILITY
  - e) SEALABILITY

4. FINALLY ANY METHOD USED MUST CONSIDER THE LAB-FIELD <u>PERFORMANCE</u> OF THE <u>MIX</u>; NOT THE INDIVIDUAL MATERIALS.

FROM THE MANY NOTIONS PRESENTED HERE, I THINK YOU'LL AGREE THAT MUCH MORE IS TO BE LEARNED AND THAT THERE IS NO NEED TO WORRY ABOUT RUNNING OUT OF IDEAS FOR OUR COMMITTEE'S WORK!

WE INVITE YOUR COMMENTS AND OPINIONS TOWARDS DEVELOPING A SIMPLIFIED & MORE RATIONAL APPROACH TO DESIGN FOR THIN LAYERED COLD MIXES & SLURRY SEALS.

THANKS.