DRAFT NOT FOR PUBLICATION

LASER MEASUREMENT OF MULTILAYER COMPACTION RATES TO DISTIGUISH BETWEEN CONVENTIONAL SLURRY SEAL AND POLYMER MODIFIED MICROASPHALT CONCRETE.

BY

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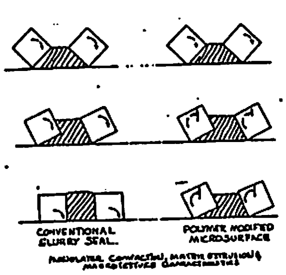
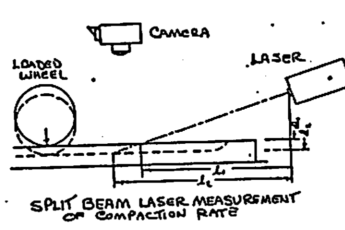
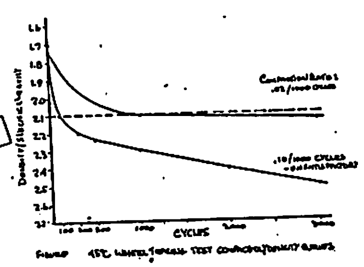






The primary difference between Slurry Seal and Polymer Modified Micro Asphalt Concrete (Cold MAC) is found in their **DIFFERENCES IN RESPONSE TO COMPACTION BY TRAFFIC.**

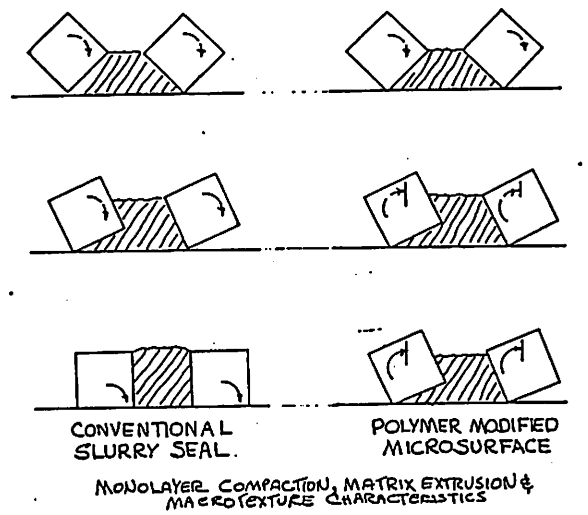


Fig.1 Monolayered slurry systems will typically loose macrotexture due to soft matrix extrusion as traffic compacts the mix; i.e., the larger aggregates assume their "most comfortable position". On the other hand, Polymod cold MACs resist compaction because of a matrix stiff enough to prevent complete compaction; more like mix consolidation rather than compaction.

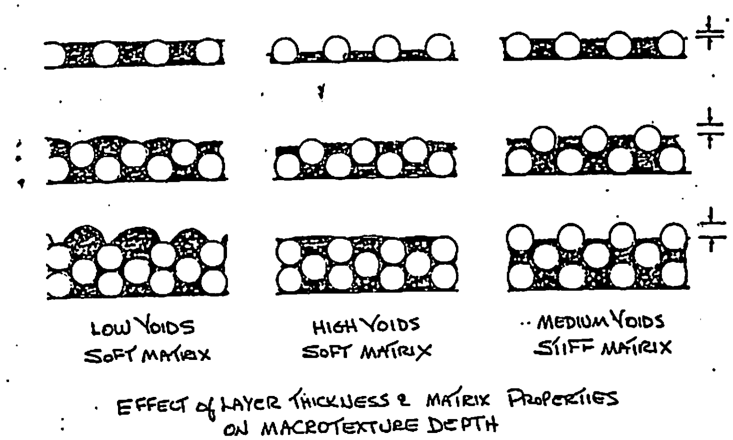
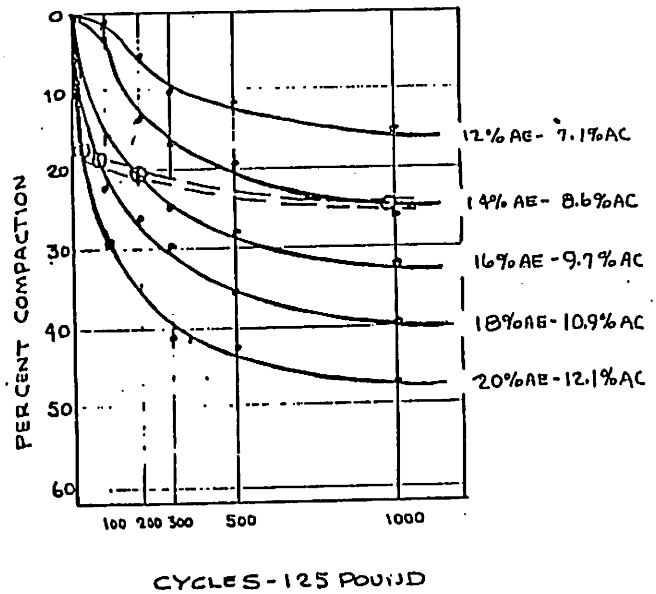
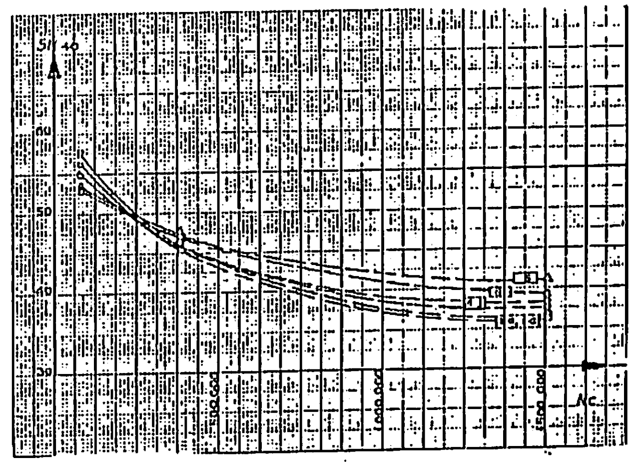


Fig. 2 Multilayered soft matrix slurries loose macrotexture as layer thickness increases, while the stiff matrix cold MAC's macrotexture actually increases with layer thickness.





שרטוט מס' 8: ערכי התנגדות להחלקה של מישטחי תערובות כולח שנמדדו במארס 1975
במהירות של 40 מיל לשעה, כפונקציה של Nc - מספר המעברים של כלי
רכב כבדים על פניהם.

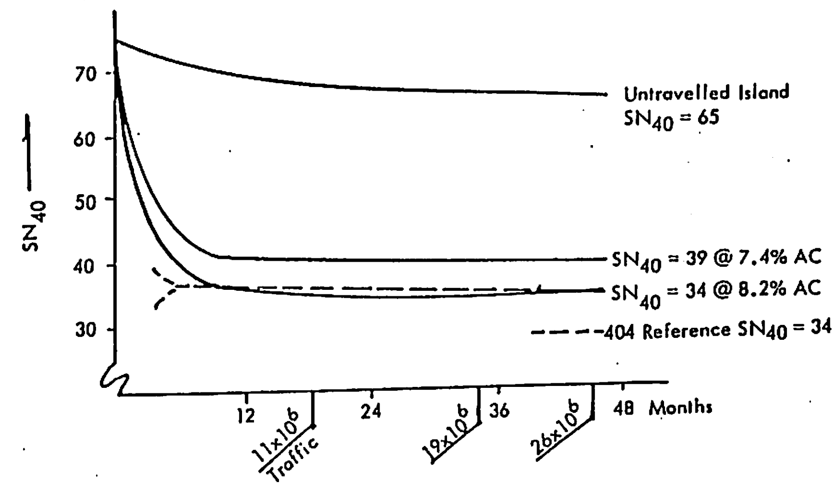


Figure 1. Effect of Asphalt Content on A-B Road Test Skid Numbers after 45 Months and 25,000,000 Accumulated Traffic

Fig. 3 At the ISSA 13th convention in Las Vegas 1975, we introduced concepts of rolling, dynamic compaction on slurries in order to examine the effects of traffic. The then new Loaded Wheel Tester was used along with a profilograph to develope compaction curves. The rate of compaction or vertical displacement was shown to be directly related to the percent binder. The macrotexture curves from a 1975 Israeli study of wet pavement slipperiness suggested that 1000, 125-lb LWT cycles were roughly equal to 1,000,000 heavy vehicle passes. The A-B test road data appears to roughly confirm this observation; i.e., a high intial rate of compaction followed by a more or less stable rate of decline. These compaction characteristics were also related to the FN_{40}.

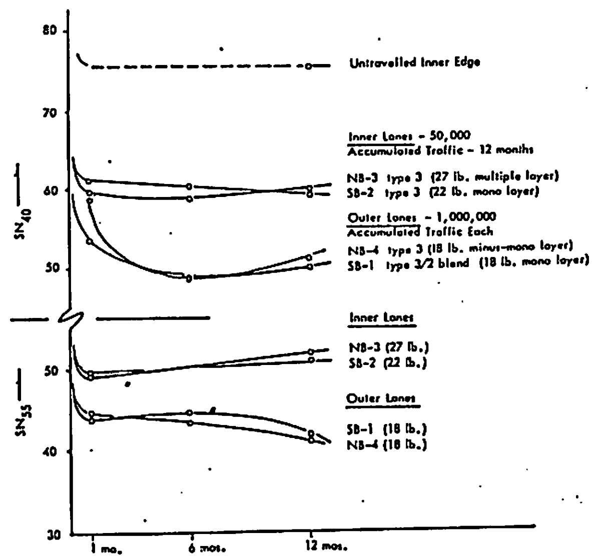


Figure 2. ODOT project no. 738-1977. Coarse type C (III) slurry seal skid analysis after 12 months and 2,000,000 accumulated traffic.

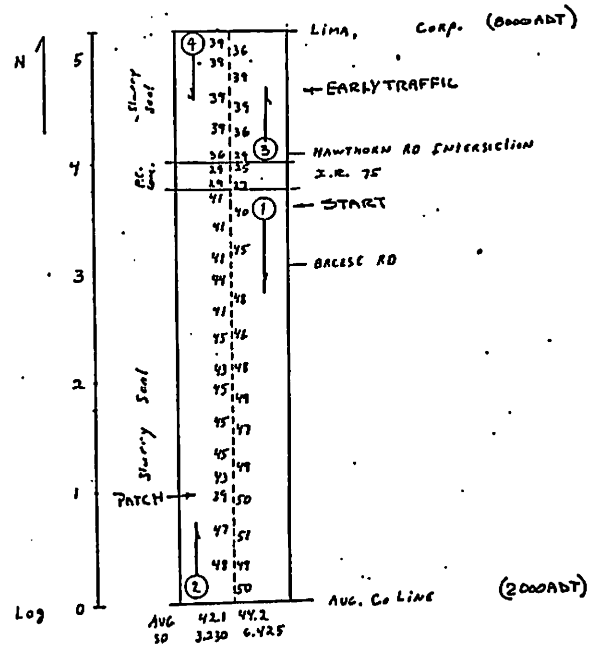


Figure 3. Skid Resistance Tests, SR 65. Project 563-78 (November 2, 1978)

Fig. 4 That traffic counts effect the rate of compaction or lowering of the FN_{40} is clearly seen by the Ohio State Route 42 and 65 field data.

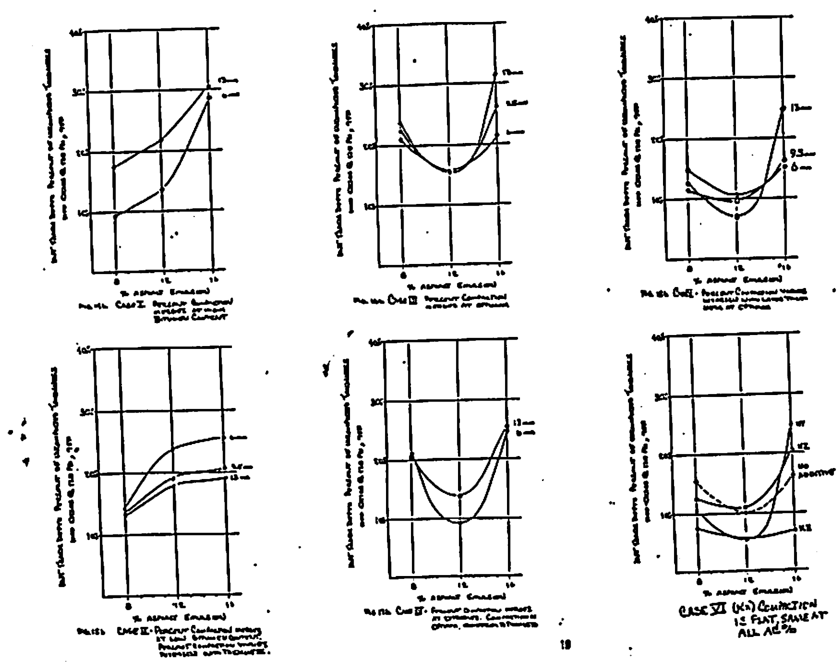
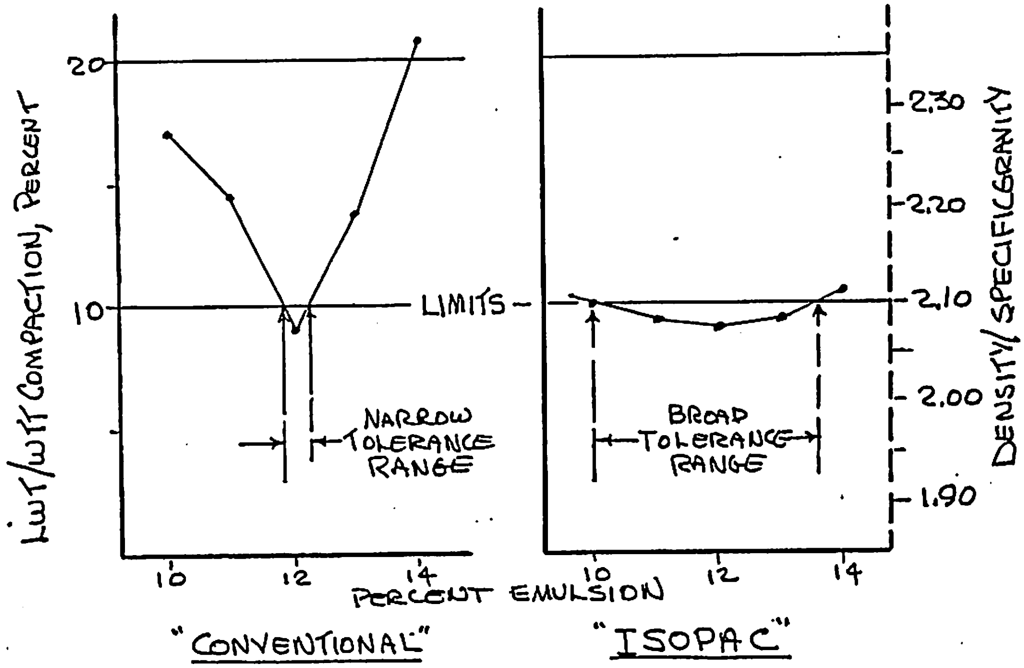


Fig. 5 The LWT was used in our 1987 Geneva study to classify 5 varieties of compaction response to layer thickness. Since then a 6th category which we call "ISOPAC" has been added. "ISOPAC" systems are those that compact at the same rate; i.e., their compaction curves are essentially flat irregardless of bitumen content.



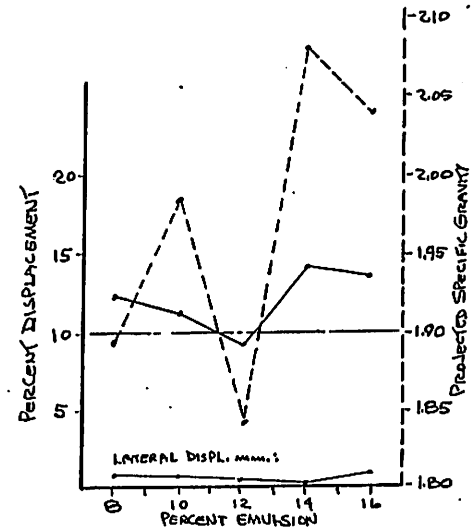
CLASSIFICATION OF POLYMER MODIFIED MICROASPHALT SYSTEMS BY COMPACTION CHARACTERISTICS

Fig. 6

We are not contemplating our navels..."ISOPAC" systems do indeed exist. Conventional Polymod Cold MACs respond to the multilayer LWT vertical displacement test with a usually rather sharp inverse Marshall Stability curve where there is a very specific, narrow bitumen tolerance range required to meet a certain criteria (e.g. 10% max. vertical displacement). The Isopac multilayer displacement curve has a very broad tolerance range. This broad tolerance range virtually guarantees field success over a wide range of possible field contingencies.

Ballou, O'Connell, Engber and Reinke reported to our 1989 Kona meeting remarkably hi void contents and low densities of successful 4-year field samples. They reported typical 2.00-2.10 densities and voids from 8-12% and even much higher.

Coyne's investigation (Kona) also suggested a typical hi void window of 8-12%. Doyle and Benedict (Kona) also related high void contents as a characteristic of Compacted Modified Cold MACs.



MULTILAYER LOADED WHEEL VERTICAL DISPLACEMENT vs. PROJECTED DENSITY (1000, 125 LB LOADED WHEEL CYCLES) etc

GADAA-1987

Fig. 7 Our lab data relating density to compaction characteristics has been scant but we did recover one data set from our Geneva study which clearly shows a relation between compaction or vertical displacement and compacted density.

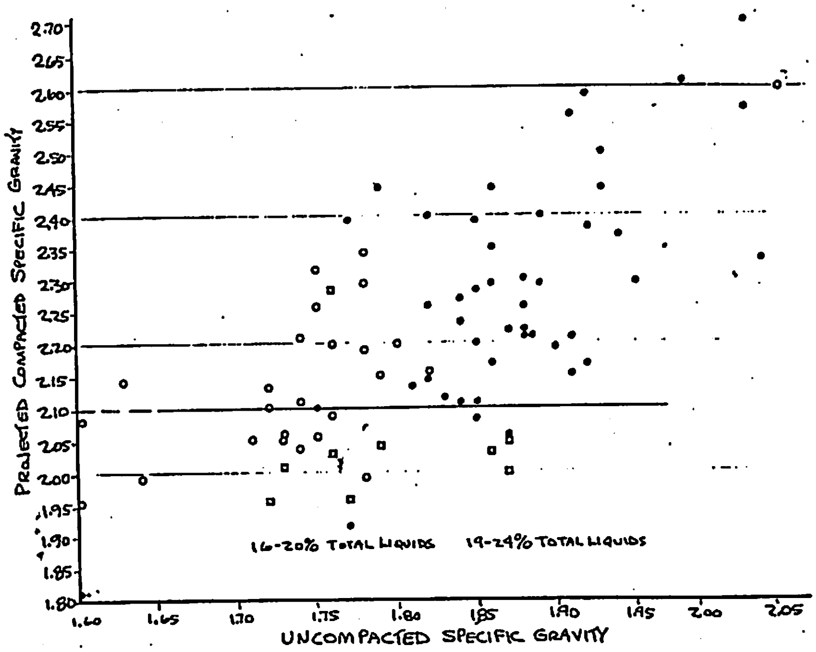


Fig. 8 In a recent lab study of the compaction characteristics of 76 mixes using a constant aggregate and 11 polymer modified emulsions we examined also the uncompacted and compacted density relationship to compaction.

We found a slight correlation of uncompacted to projected compacted specific gravities and that only those cast at 1.70 to 1.80 met the Ballou 2.10 compacted criteria.

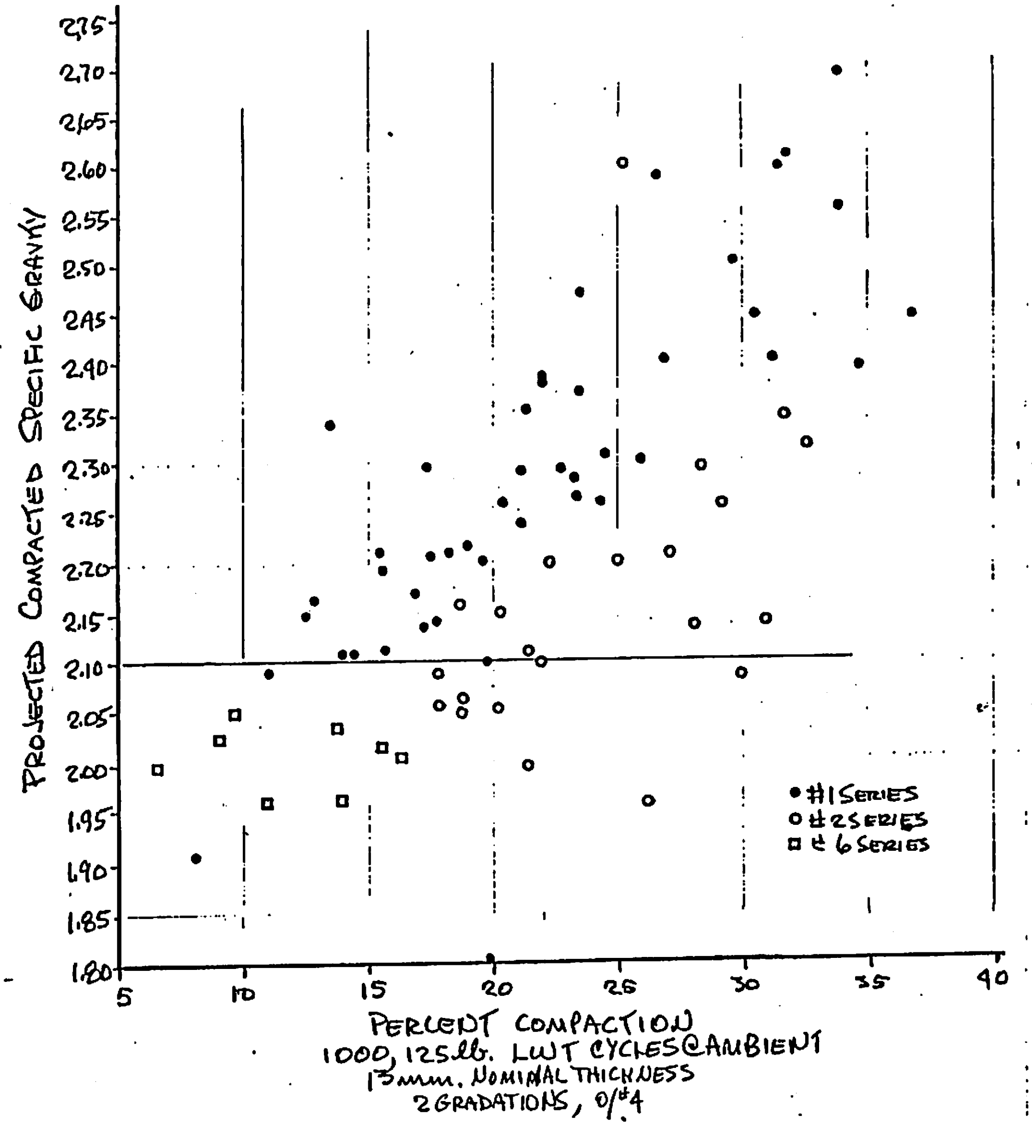


Fig. 9 The percent compaction - projected compacted specific gravity plot correlates much better. Here, percent compaction may be as high as 20-25% and still meet the Ballou 2.10 density criteria.

It seems that our original Polymod Cold MAC performance criteria of 10% and 5% maximum vertical and lateral displacement is not universally applicable and that a projected density criteria of 2.0 to 2.15 max should be included if indeed is an indicator of successful field application.

The British Wheel Tracking Test uses a Vertical Displacement critéria for compacted mixes of a of 2 mm per hour at 45°C for very heavy traffic (6,000 commercial vehicles per day). For a 50 mm specimen, this would be 4%/hour or, at 44 cycles per minute, or 1.5% per 1000 cycles or at 2.00 specific gravity, a rate of specific gravity increase of .03 per 1,000 cycles at 45°C; less at lower temperture.

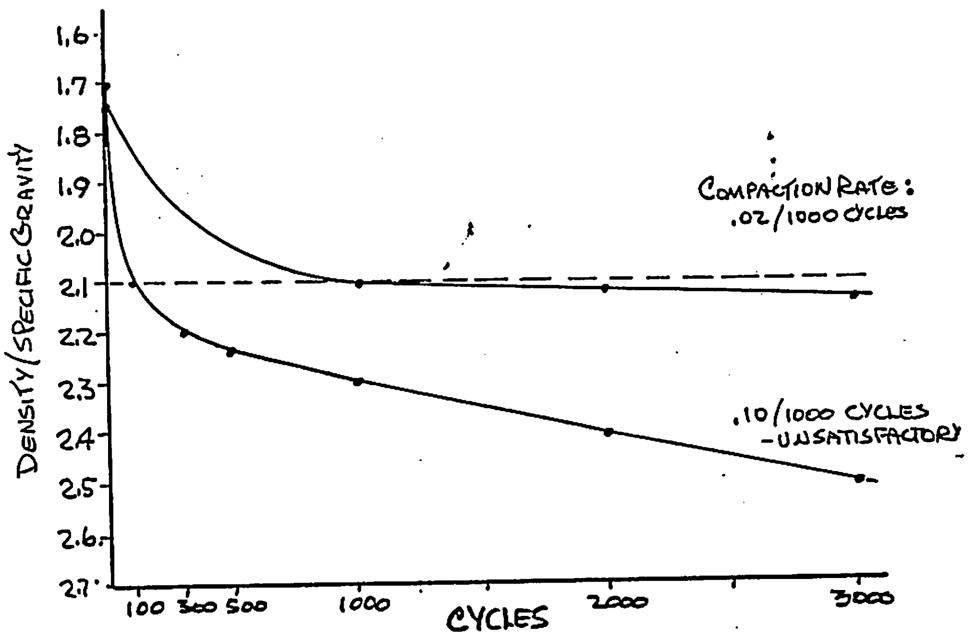


FIGURE 45°C WHEEL TRACKING TEST COMPACTION/DENSITY CURVES

Fig. 10 The rate of density-compaction curves would then look like this where the contrast between conventional, "soft matrix" slurry and "stiff matrix" polymer modified microasphalt becomes quite clear.

There is an initial fast rate of compaction, but then slows to a steady rate of compaction. Each system has it's own characteristic curve: one satisfactory for multilayers under heavy traffic while the other is not.

Our immediate problem is to develope a simple method to measure the rate of compaction <u>during compaction</u> rather than laboriously unloading the machine periodically to manually measure the dimensions of the sample with calipers or profilograph as in the past.

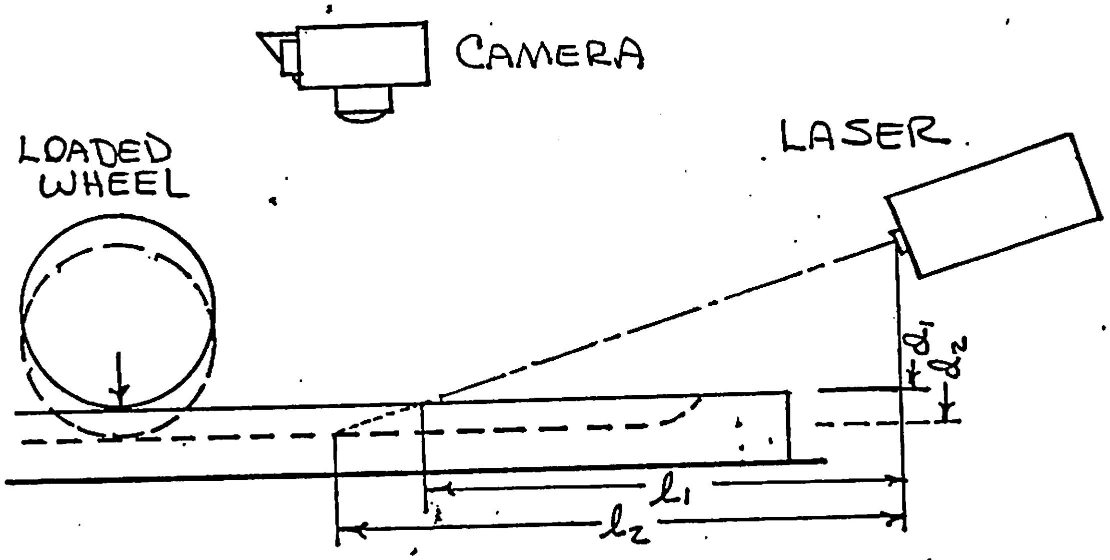


Fig. 11 We have selected initially to try multiple split laser beams focused near the center of the sample at a 10° angle and to periodically measure the horizontal distance between the laser source and target. Simple trigonometry and arithmetic yields the depth of the Wheel Track. A plot of periodical measurements during compaction will show the rate-of-compaction curve.

Physical measurements and measurements from photographs agree closely. We are encouraged by our initial results and plan to refine our methodoloy this coming year.

Fig. 12 Finally, we propose the following description of the laboratory parameters of Polymer Modified Microasphalt concrete:

DESCRIPTION. POLYMER MODIFIED MICROASPHALT SHOULD BE:

1. --- capable of being spread in variably thick cross sections (wedges, ruts, scratch courses) which,

2. --- after initial traffic consolidation, does not further compact (resists compaction) throughout the entire design tolerance range of bitumen content and variable thicknesses to be encountered and,

3. --- maintains good macrotexture (high wet coefficient of friction) in variably thick sections throughout the service life of the microsurface.

MIX DESIGN TESTS SHOULD MEET OR EXCEED THE STATED VALUES:

Mix time @ 23C (Controllable) ISSA TB 113	Controllable to: 120′ min.
Wet Cohesion @ 60′. ISSA TB 139	20 kg-cm. min.
60C Cured Cohesion. ISSA TB 139	24 kg-cm. min.
Classification Compatibility, Schulze-Breuer-Ruck ISSA TB 145	(AAA, BAA) 11 grade points min.
Wet Track Abrasion Test ASTM D3910, ISSA TB 100; 1-hr. soak	24.5 grams max. (75g/SF at optimum)
6-day soak	24.5 grams max. (75g/SF at optimum)
Monolayer Loaded Wheel Test Sand Adhesion ISSA TB 109	50 g/SF max.
Multilayer Loaded Wheel Test Displacement @ ambient and optimum Bitumen ISSA TB 147A	10% vertical, 5% lateral
Multilayer Wheel Tracking Displacement @ 45C ISSA TB 147B	10% vertical, 5% lateral
Rate of Density Compaction	.02/1000 cycles max.
Compacted Density, 1000 cycles	2.10-2.15 max.
Compacted Voids	8 to 18%
Multilayer Wheel Tracking Macrotexture	1 mm min.
Low Temperature 4C Flexural Tension Test ISSA TB 146	8 mm min.

SUMMARY

The distinguishing difference between conventional slurry and polymer modified microasphalt has been shown to be their differing rates of traffic compaction. Both rates of density change and vertical displacement may be easily determined by insitu laser measurements. Minimum values for laboratory properties of polymer modified microasphalt is presented.

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