MATERIALS & RESEARCH DIVISION

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RESEARCH UPDATE Number U93-4

ANALYSIS OF PREMATURE LONGITUDINAL CRACKING

BACKGROUND:

Premature longitudinal cracking was identified on Rte 302 Ryegate-Newbury, which included reclaimed base, and Rte 105 Troy-Newport, which included cold in-place recycling. The cracks were in addition to the center line paving joint crack which has often occurred in the surface course on recent overlay projects. The initial concern was that if the longitudinal cracking related to the reclaimed or recycled courses beneath the new bituminous pavement, immediate corrections in the specifications would be justified to prevent such distress on future projects.

INVESTIGATION PROCESS

The investigation began with a request to the DTA's to inspect all 1991 and 1992 contract paving projects and report the extent of `ongitudinal cracking.

The paving contractors were contacted via their PAV committee representatives and asked to investigate the problem and provide input at a meeting with the Agency scheduled for April 16, 1993.

Representatives from Construction, Pavement Management and Materials & Research were asked to provide their comments and ideas at a meeting held on April 13, 1993.

D.T.A. COMPILED PROJECT INFORMATION

The responses from the DTA's varied widely in detail and description. Most dealt with cracking in bituminous overlay projects with the majority of the premature cracking occurring at the centerline paving joint. With regard to reclaimed or recycled, District #7 noted the cracking on Ryegate-Newbury and District #6 noted longitudinal cracks in the shim course over reclaimed base on the Rte 12 Bethel-Randolph Project. District #9 (contacted by phone on April 13, 1993) reported very little cracking on the numerous reclaimed projects in their District.

RTE 302 & RTE 105 PAVEMENT CONDITION INFORMATION

The Rte 302 Ryegate-Newbury F026-1 (37) project included an overlay segment (MM 1.400 - MM 3.253) with a leveling course and 1 1/2" Type III op and a reclaimed segment (MM 3.253 - MM 1.675) with a 2" Type II binder and 1 1/2" Type III top.

The standard overlay segment of the project has extensive reflective cracking. The two test sections revealed 60' of cracks per 100' of roadway on April 19, 1993. Approximately 32% of the full width transverse cracks and 5% of the longitudinal cracks had reflected up through the new overlay after less than one year of service.

The reclaimed segment of the project has limited longitudinal cracking approximately 2'9" left and right of center line. Where there is no cracking, there is visual distortion in the pavement at that offset over the entire length of the project including the standard overlay section. The variation in the surface texture noted often requires close observation and the proper surface condition to be detected.

There are a few other longitudinal cracks at offsets other than 2'9" left and right of centerline. Prior to recycling, the test sections averaged 388' of cracks per 100' of roadway. Currently, cracking averages 16' per 100' of roadway in the test sections but there is a potential for an additional 153' of longitudinal cracking per 100' in the immediate future along the transition lines noted.

Cores taken from the reclaimed section of the project reveal that the cracking has initiated at the pavement surface and has extended down through the binder course also where the surface width of the crack $\sim xceeds 1/4"\pm$.

Rut measurements taken in the test sections revealed a maximum value of the 1/16" with no measurable rutting at 95% of the locations.

The Rte 105 Troy-Newport F034-2 (10) S project included a 4" deep in-place recycle treatment topped with a 1 3/4" Type II binder course and a 1 1/4" Type III top.

The pavement has lines of visual distortion approximately 7 1/2' left and right of centerline over most of the project length. The 7 test sections on the project revealed an average of 41' of paving joint cracks and 55' of other longitudinal cracking on April 21, 1993. In addition, there is a potential for an additional 90' of longitudinal cracking per 100' along the transition lines noted and there is some cracking approximately 2 1/2' left and right of centerline although none occurred in the test sections. It should be noted there were no longitudinal cracks other than at the centerline when the project was inspected on March 3, 1993.

Cores taken from the project reveal that the cracking has initiated at the pavement surface and has extended down through the in-place recycled course at locations where the crack width was significant.

Rut measurements taken in the test sections revealed a maximum value of 1/16" with no measurable rutting at 91% of the locations.

PAVING EQUIPMENT INFORMATION

Different pavers were used on the Rte 302 and Rte 105 projects but both were equipped with power extendible "OMNISCREEDS" between the 1991 and 1992 paving seasons. The BLAW-KNOX paving manual warns that continuing adjustments may be required on the "OMNISCREEDS" to insure a uniform texture across the mat and the absence of any tearing and or transition lines (see paving manual information attached).

When our Paving Engineer reported the premature cracking problem at the recent Tri-State Construction Engineer's Conference, Maine DOT personnel immediately responded that the pavers were probably equipped with "OMNISCREEDS". They had experienced similar problems and were working closely with the contractors and their paving inspectors to insure a satisfactory and uniform mat texture.

When contacted regarding the potential screed problem, New Hampshire construction personnel had no knowledge of premature longitudinal cracking but were familiar with the problem. On one project in 1992, the Resident Engineer noted a distortion in the mat and stopped the paving operation. Adjusting the equipment required two full days to provide the needed corrections.

BITUMINOUS MIX INFORMATION

The Rte 302 and Rte 105 projects were paved with bituminous mixture 'ich had been modified from the designs used in 1991 and earlier. The odifications were primarily designed to increase mix stability and rut resistance. They included a change in the gradation which reduced the amount of aggregate passing the #8 sieve by up to 10%, a minimum of 60% of the material passing the #8 sieve had to be stone screenings and a Marshall Design requiring 75 blows rather than 50 blows. The modifications typically reduced the asphalt content of the mix by 1/2 to 1%.

As noted earlier, the stiffer/coarser mix has rested rutting on the two projects studied in detail. However, the stiffness of the mix may be a factor which has contributed to the crack development at the weak points in the pavement mat. For example, the paver (PF 180, 62-5012) used on Rte 302 was also used on Rte 5A Westmore-Brownington and although there is some distortion visible left and right of centerline, there is no premature longitudinal cracking on Rte 5A. Both projects included standard overlay and reclaimed base segments. The major difference between the projects was the Rte 5A surface course and part of the binder course utilized the pre-1992 fine mix design. The narrower roadway typical on Rte 5A and other projects may also have had an influence since it reduced the amount that the "OMNISCREEDS" had to be extended.

DISCUSSION

The information relating to the construction of the projects under study and their condition after 7 - 9 months of service was discussed in detail with involved Agency personnel on April 13, 1993 and again with

dustry representatives on April 16, 1993. Although many different factors were discussed, there was a general consensus among all disciplines that equipment adjustment and to a lesser degree the harshness of the mix were the cause of the premature longitudinal pracking. Plans were discussed to hold a paving equipment seminar for industry and state personnel as soon as possible. One of the expected products of the seminar would be an equipment check list for both the paving crew and the state inspector which would help reduce the risk of irregularities in the paving mat on future work.

CONCLUSIONS

- Only two projects, Rte 302 in Ryegate-Newbury and Rte 105 in Troy-Newport have experienced significant premature longitudinal cracking.
- 2. Both projects had transition lines or slight variations in the surface texture of the paving mat at specific locations due in some cases to the use of screed extensions required to pave the desired widths. The lack of mat uniformity was not noted during paving but might have been avoided with more precise adjustment of the screeds.
- 3. Bituminous mixes produced for both projects were based on a 75 blow Marshall design which resulted in a lower AC requirement and that combined with the new coarser gradation with approximately 10% less aggregate passing the #8 sieve resulted in a harsher less forgiving mix which failed by cracking at the weak points (transition lines) in the pavement.

The reclaimed or recycled base courses on the two projects had no measurable effect on the development of the premature longitudinal cracking.

5. The centerline paving joints are experiencing a high rate of premature cracking state wide.

RECOMMENDATIONS

- 1. Limit the use of the 75 blow Marshall design to urban and or high traffic locations where the risk of rut development is significant.
- 2. Consider variations in the aggregate gradation and the grade of asphalt which will result in a more forgiving mix.
- 3. Train the paving crew and the state project inspectors to recognize and correct deficiencies in the paving mat which may otherwise result in future cracking.
- 4. Specify and evaluate new equipment or procedures designed to eliminate premature paving joint cracking.