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PROJECT 7742519
SECOND INTERIM REPORT
WINTER 1971-1972

WINTER PAVEMENT PATCHING MATERIALS AND TECHNIQUES

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Winter Pavement Patching, Materials & Techniques

Introduction: This interim report discusses the second year of an experimental winter pavement patching study for the Federal participating Project #7742

The purpose of this investigation is to find materials suitable for rapid, relatively long lasting economical winter patching of portland cement and bituminous concrete pavements and to develop efficient techniques necessary for their placement.

The winter 1970-71 phase of the study investigated the use of the standard winter mix and an asbestos modified winter mix with the lower hole and material preparation effort techniques. Described as Techniques 1 and 2 in Table 1. A smaller amount of data was collected on patches placed utilizing a heated trailer unit and on hot-mixed material which became available toward the end of the winter.

It had been planned to investigate these bituminous materials with the higher hole and material preparation effort techniques (Techniques 2, 3, and 4) and three types of fast setting concrete patching products during the 1971-72 winter.

Location

The site chosen for the winter 1971-72 phase of the project was a 12 mile section of Route 130 in the vicinity of Hightstown. At this

TABLE #1 TECHNIQUES

NUMBER	DESCRIPTION	EQUIPMENT
1	Fill hole in one lift with mixture, and compact by hitting the patch with the back of a shovel twice. No effort to be made to dry or shape the hole, and no painting of the exposed surfaces of the hole.	Shovels
2	Same as #1 above, except compact using a 64 sq. in - 23.5# $\pm$ hand tamper with a compactive effort of 10 blows per unit area of the tamper (1' $\pm$ free fall) applied in a random manner over the surface area of the patch, shape the hole, remove all loose material by hand, and paint the exposed surfaces of the hole with RC-70. (This technique in combination with mix #1 is designated as the control for this study.)	Shovels Tamper
3	Same as #2 above, except shape the hole with a pavement breaker, compact the patch with a small roller, and the patch material shall be preheated at the job site in a McConnoughay HTD mixer. The material will be mixed at a temperature recommended by bituminous suppliers, which will be recorded as part of the data.	Shovels Small vibratory roller Pavement breaker McConnoughay HTD mixer
4	Same as #2 above, except that a small roller shall be required for compaction.	Shovels Small vibratory roller

location, Route 130 is primarily dualized portland cement concrete pavement with an AADT of approximately 20,000.

Deviation from Work Plan

During the last half of December 1971 over fifty patches were placed with hot plant mix (FABC, Mix #5) due to the fact that a nearby asphalt plant was still mixing and regular winter mix was not yet available. Besides these reasons, FABC was included in the study to investigate the general impression that the winter patching problem could be diminished if hot plant mix was available throughout the winter patching season.

The late availability (last week in January) and early removal (second week in March) of the specialty patching crew severely limited the quantity of patches that could be placed utilizing techniques 3 and 4 (ref. Table 1) due to the extra manpower requirements. The installation of experimental patches was further curtailed by prolonged periods of inclement weather.

Bituminous Type Materials

The bituminous patching materials evaluated during this phase of the project are described in Table #2 in the Appendix. They include the standard RR winter patching mix, an asbestos-modified cutback asphalt patching mix, "zero-mix", and a mix No. 5 gradation hot mix. Observations relative to the mixing and storage characteristics of several of these materials revealed several areas of potential operational difficulties.

The mixing of the asbestos material presents some problems, for unless a large quantity (in order of 100's of tons) of the material is to be mixed, the bags of asbestos have to be added by hand into the plant's pugmill inspection hole for each batch. If a large quantity of material is to be mixed, a silo or a conveyor belt could be set up to feed the asbestos fibers directly into the pugmill.

Mixing the material also poses potential problems concerning worker safety and air pollution, for asbestos fiber is mentioned quite frequently as a possible cause of lung cancer in not only workers who handle the fibers, but also people living in the general area of the plant.

The smaller the quantity required, the greater the cost of mixing due to slowing down the plant production by manually feeding the fibers plus the added expense of extra men needed to handle the fibers. The cost of the fibers alone would raise the cost of material from approximately \$10/ton to \$12/ton.

These drawbacks plus the relatively mediocre performance as compared to the standard winter mix (RR) resulted in the decision to terminate experimentation with the asbestos-asphalt patching material after the 1971-72 winter phase.

It is planned for the winter 1972-73 phase to investigate in greater quantity Zero-Mix, a proprietary product of Tri-County Asphalt, with the higher compactive techniques to see if an improvement can be made to its rather poor performance to date. Currently, this material is being used in one part of the State for it is more readily available than the RR mix.

The drawbacks to FABC are that it can't be stockpiled, it has to be picked up at the plant each day, and time will be lost while a truck goes to the plant to get loaded.

A portable heated storage trailer, like the one which was loaned to the study by the manufacturer during the winter 1970-71 phase, would be ideal to use to keep the FABC mix hot during the winter months. A nearby asphalt plant would probably remain open longer in the winter months (close later, open earlier) if he could be assured of a sufficient demand for hot material.

Fast Setting Concrete Products

The fast setting concrete patching materials were as described below:

a. Octocrete - Penn Crete Products, Inc.
   Philadelphia, Penna.

b. Speed Crete - Speed Crete Cement Materials
   Itasca, Illinois

c. Fast-Set PreCrete - Pocono Fabricators, Inc.
   East Stroudsburg, Pa.

Little success was obtained patching roadways with the three types of fast setting concrete products during the winter phase. Speed Crete was the only product that set up within a normal work day in the 20° to 40°F ambient temperature range. However, even the patches that did set up, cracked within a few days and failed within a few weeks.

Patching Techniques for Bituminous Type Patches

As shown in Table 1, a listing of patching techniques by the order of increasing hole and material preparation effort is 1, 2, 4, 3. Techniques 1, 2, 4 investigate various compactive efforts, ranging from the back of a shovel to a tamper to a small vibratory roller.

Technique 3 utilizes a portable pugmill to reheat the material. In practice, the material was heated up to 160 to 200°F range, with 180°F as a target value. Different size loads, ambient temperatures, and rain water content tended to vary the temperature within the range from batch to batch.

The material was reheated on the job site after the hole was prepared (see Table 1 for complete description). Therefore, the material was placed into the holes and rolled at nearly the same temperature as that at which it was mixed with little resultant temperature loss. Also, sufficient time for the material to cool and set-up was assured as the work site was always in a coned-off area and not opened to traffic until late in the afternoon.

Loading the mixer with material and placing the material into the holes was relatively simple when the pugmill was towed by a dump truck. With the truck's tailgate down, material was shoveled directly into the pugmill's hopper and the heated material then dropped onto a pan about one foot above the ground to be readily shoveled into the hole.

Towing the pugmill instead of having a central location for mixing, greatly reduced the problem of running short of hot material and having to throw cold material into the hole to fill it up until heated material could be obtained at a later date.

It further appeared that towing the mixer permitted a reduction in wasted material as only that material needed is reheated at the job site and the unheated material left on the truck at the end of the day can be put back into the stockpile for reuse at a later date. If the truck was loaded with only reheated mix from a central location, as soon as the material lost too much heat, it would lose its workability and be useless for patching. It is felt that work at the job site can be planned better towing the mixer for time is not lost sending a truck to a central location for heated material.

It seems practical to tow the pugmill with the patch truck to insure enough heated material and enable better planning at the job site and to reduce waste and lost time.

The most practical use of the vibratory roller was where the holes were congregated in groups. This limited driving the roller any distance for its top speed is only a few miles per hour. Following compaction of one grouping the roller was placed on its trailer to be towed to the next grouping. Outside of moving to the next hole, about the same amount of time was required to compact the patch as with a hand tamper.

Technique 2 (tack and tamper) in conjunction with the RR mix was designated as the control material- technique and is most typical of the current patching method used by the maintenance crews.

Technique 1 (back of shovel) represented the minimal compactive effort, for the material was just thrown in the hole with no prior preparation and hit with the back of a shovel. However, the greatest number of holes can be patched in this manner for no time is required to prepare the hole or tamp the patch. Its use should be limited to where a large number of holes, spread out over a long distance, have to be patched in a short period of time, such as often occurs before weekends or holidays during prolonged periods of inclement weather. These patches can be repatched at a later date when possibly more time is available for patching properly.

Monitoring

For the 1971-72 winter phase, the method used to monitor the life of the patches was changed from that of the first year as the monitoring period was extended from mid-April to the end of August to get a better feel for the overall life of a patch.

Estimated Time of Failure

In establishing time-to-failure values, the problem arose as what to do with the patches that hadn't failed when the monitoring period had ended. It was decided to assign an estimated failure date to these patches based on the individual patch condition and the previous failure rate for that material-technique combination.

Weather

Weather information, such as precipitation, snowfall, and freeze-thaw cycles, was obtained from the Federal government's monthly climatological data publications.

Percent Failure

Instead of relying upon percent failure at specified dates such as mid-April as was done the first year for evaluating the patching techniques and materials, the average days to failure and the effect of the weather was used for analyzing the results of the winter 1971-72 phase.

Average Days to Failure

The performance of the test patches placed during the 1971-72 winter is partially indicated by the data of Table 3 which lists, by material type and installation technique, a patch's average days to failure. Analysis of this data reveals several important trends.

With the RR mix, the higher the hole and material preparation effort the longer the time to failure. The longest time to failure was with technique 3 and the shortest was with technique 1. This apparent linear relationship between increased hole and material preparation effort and related increase in patch life also holds true for zero-mix and FABC.

Using the RR mix with technique 2 as a standard reference point (STD) to compare with other material-technique combinations, the shovel compaction technique (technique 1) and the RR mix was 13% less effective while a 30% increase in life was obtained using the vibratory roller (technique 4) and RR mix. A huge 60% increase was obtained by reheating the RR (technique 3).

A 10% and a 35% improvement over STD was obtained by using FABC with techniques 1 and 2 respectively.

However, zero-mix with technique 1 produced a 60% decrease and with technique 3 a 25% decrease in patch life. The use of the tamper resulted in a 40% reduction in life. Use of the roller (technique 4) only increased the patch life over that with the tamper (technique 2) by an insignificant 3%.

For some unexplainable reason, no recognizable pattern occurred with the asbestos material. The asbestos mix with technique 3 produced an 80% increase in patch life and only a 4% decrease with technique 1. However, unlike the other materials, the asbestos mix with techniques 2 and 4 produced a 17% and a 20% decrease in life respectively. The increase with technique 3 does not seem to warrant the increased costs and hazard associated with this material.

Days to Failure per Inch of Precipitation

Table 4 lists the days to failure per inch of precipitation, which is the total precipitation for the life of the particular patch divided into its respective time to failure and averaged for the material-technique combination.

As shown in Table 4, there was no appreciable difference between the various material-technique combinations, for all values were within ± 10% of STD. This parameter seems to have had an equal effect on all the various combinations.

Days to Failure per Freeze-Thaw Cycle

Table 5 lists the days to failure per freeze-thaw cycle, which is the total freeze-thaw cycles for the life of the particular patch divided into its respective time to failure and averaged for the material-technique combination.

A freeze-thaw cycle was assumed to occur when the maximum and minimum temperatures for any 24 hour period obtained from the Federal Government's monthly climatological data publications were above and below freezing (32°F) respectively. This method produced a conservative estimate of the number of cycles occurring during the obserged period.

Aside from RR techniques 3 and 4 and asbestos technique 3, all the other material-technique combinations were 30% to 60% below STD (ref. Table 5). This seems to indicate that whereas precipitation did not greatly effect life, freeze-thaw cycles had a great influence.

Conclusions

Overall, the standard winter mix (RR) performed very well as compared to the other materials. If the time, equipment, and manpower are available, the extra hole and material preparation techniques will produce a longer life expectancy.

Zero-mix, on the other hand, doesn't compare very well with the RR mix, even with the higher hole and material preparation techniques for the life expectancies are about one-half that obtained using the RR mix and the same respective techniques.

The performance of the asbestos mix was somewhat comparable to that of the standard RR mix when heated in the McConnaughay mixer. However, its performance otherwise was substandard. In view of the mixing difficulties, substantial cost increases, health hazards, and lack of significant improvement in patch life over that for RR mix future experimentation with this material is considered unwarranted.

The use of FABC as a winter patching material deserves further investigation, particularly with technique 4.

The performance of the fast setting concrete patching materials in sub-freezing weather precludes their general use as a winter patching material. They do appear to have some value as a longer-lived patching material for bridge decks or concrete pavements when used with ambient temperatures of 40° or higher. Use on concrete pavements should be avoided near joint areas where high resultant stresses cause premature patch failure.

TABLE #2 MATERIALS

NUMBER	DESCRIPTION
1	Inverted emulsion winter patch mix (RR) from Trap Rock Industries Plant in Kingston.
2	"Zero-mix" (Asphaltic phase made up of a powdered hard asphalt and an asphaltic flux oil with a minor percentage of a liquifier) from Tri County Asphalt Plant in Rockaway.
3	Asbestos - Cutback Asphalt-Patching Mix (per Johns-Manville specifications) from A. E. Stone Plant in Pleasantville.
4	FABC (Specification Mix #5) from Brunswick Bituminous Plant in Dayton.

TABLE NO. 3

Technique	Material	Average Days to Failure 1	2	3	4	Percent of STD 1	2	3	4
1		119	52	132	151	87	38	96	110
2		137	87	114	185	STD	63	83	135
3		222	104	249	---	162	76	182	---
4		177	90	111	---	129	66	81	---

TABLE NO. 4

Technigue	Material	Days to Failure per Inch of Precipitation				Percent of STD			
		1	2	3	4	1	2	3	4
1		7.8	8.2	8.0	8.9	100	105	102	115
2		7.8	8.5	7.9	8.1	STD	109	101	105
3		7.0	7.5	7.0	---	90	97	90	---
4		7.2	6.8	7.4	---	92	88	95	---

TABLE NO. 5

Technique	Material	Days to Failure per Freeze-thaw cycle				Percent of STD			
		1	2	3	4	1	2	3	4
1		3.1	2.5	2.1	2.1	62	49	42	41
2		5.1	3.4	2.2	2.3	STD	68	43	45
3		6.1	2.6	5.5	---	120	51	109	---
4		4.8	2.4	2.7	---	96	48	51	---