Potholes Patching - A Review on Materials, Testing, and Procedure for Repair

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Abstract— Road development is considered one of the most important processes for improving the nation in terms of economical development. The main concern in today's world is to reduce the number of potholes that are an annoyance to road users and potentially a dangerous hazard on the roadway which is causing frequent accidents leading to loss of life as well as loss of property. The materials used for the filling of potholes are Cold Mix Asphalt and Hot Mix Asphalt depending on the condition of traffic. Certain tests can be adopted on the aggregates and the mix to find the optimum materials and asphalt mixtures that can be used for pothole patching. Utilization of these mixtures and making use of proper methods to fill the potholes efficiently and effectively.

Keywords: Potholes Patching, Road Development

I. Introduction

A pothole can be defined as localized distress in an asphalt-surfaced pavement resulting from the stripping of the asphalt surface and base course. The pieces of asphalt pavement are created by the action of climate and traffic load on the weakened part of pavement resulting in the pothole. To be considered as the potholes, the distress must be bowl-shaped and have a dimension of six inches. Low severity potholes are having a depth of one inch, moderate severity potholes is having depth ranging from one to two inches and high severity potholes are having a depth of greater than two inches. There are two main reasons for the formation of potholes. One of them is poor workmanship, poor mix-design. As the traffic passes over these stressed regions, the asphalt weakens and materials are removed from the surface, leaving behind the potholes. Another reason for the formation of the pothole is the seepage of water through the cracks and freezing condition. The water weakens the surfaces underneath supporting the road surface, when it freezes, it pushes the asphalt layer up and the layer underneath down, creating a weak stresses zone. Once the traffic passes over it, the surface layer breaks up and materials get loose and come out off the surrounding pavement resulting in the formation of potholes.

Fig. 1: An example of a pothole.

II. Materials and mix design of asphalt

Asphalt is a good binding material that is used and accepted in road construction industries. Asphalt when used with suitable aggregate gives excellent design aspects that are strength and stability to the road. The mix is classified into two different types:

A. Hot Mix Asphalt
B. Cold Mix Asphalt

A. Hot Mix Asphalt:

It is one of the most popular rehabilitation techniques used for pothole patching and road construction. Reclaimed Asphalt Pavement (RAP) intended for recycling is combined with the required amount of aggregates and newly prepared asphalt binder in a hot mix plant. The required amount of mix is transported to a paving site, placed, and compacted to a required level. Hot mix is having better quality control and comparable performance, this is due to the fact the constituents are mixed under a controlled condition and there is continuous monitoring of the mixing process. It requires less workspace for laying of the mix. It is found, in some of the researches, that the stiffness modulus, indirect tensile strength, and resistance to rutting performance of recycled mix is found to be better than the freshly prepared mix. Hot Mix Asphalt can be used for high-density traffic conditions

These are some of the important properties of Hot Mix Asphalt:

1) Weather-Resistance
2) Quick Cooling Down
3) Strength
4) Bend but Not Break

B. Cold Mix Asphalt:

Cold mix Asphalt is used when the environmental condition for using the Hot Mix Asphalt is not suitable like very low temperature. Cold mix is generally used for road patching and it is not as strong as Hot Mix Asphalt, but it is used for small-scale fixes or temporary fixes until a more permanent repair can be made using Hot Mix Asphalt. Hence, we conclude that cold mix can be used effectively and efficiently for rural road construction where traffic density is less and can be used on a large scale without harming the environment.

III. Mix design

The Marshall mix design method consists of 6 basic steps:

A. Aggregate selection
B. Asphalt binder selection
C. Sample preparation (including compaction)
D. Stability determination using the Hveem Stabilometer
E. Density and voids calculations
F. Optimum asphalt binder content selection.

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A. Aggregate Selection

A typical aggregate evaluation for use with Marshall mix design methods includes three basic steps (Roberts et al., 1996):

1) Determine aggregate physical properties.
2) Determine other aggregate's descriptive physical properties.
3) Perform blending calculations to achieve the mix design aggregate gradation.

B. Asphalt Binder Selection

The Marshall test doesn't have a typical nonexclusive asphalt binder determination and assessment system. Each indicating substance utilizes its technique with adjustments to decide the fitting cover and, assuming any, modifiers. Binder assessment can be founded on nearby experience, past execution, or a set technique. The most widely recognized method is the Superpave PG cover framework. When the binder is chosen, a few fundamental tests are raced to decide the asphalt binder's temperature-viscosity relationship.

C. Sample preparation

The Marshall technique, as other blend plan strategies, utilizes a few preliminary total asphalt binder blends (ordinarily 5 blends with 3 samples each for a sum of 15 samples), each with an alternate asphalt binder content. Then, at that point, by assessing every preliminary mix's exhibition, an ideal asphalt cover content can be chosen. All together for this idea to work, the preliminary blends should contain a scope of asphalt contents both above and beneath the ideal asphalt content. Accordingly, the initial phase in sample readiness is to assess an ideal asphalt content. Preliminary mix asphalt contents not set in stone from this gauge.

D. Stability Determination Using the Marshal Stabilometer

The Marshall stability and flow test gives the presentation forecast measure to the Marshall mix design technique. The dependability part of the test estimates the maximum load upheld by the test example at a loading rate of 50.8 mm/minute (2 inches/minute). Essentially, the load is expanded until it arrives at a greatest then when the load simply starts to diminish, the stacking is halted and the most extreme load is recorded.

E. Density and Voids Calculations

All mix design methods use density and voids to determine basic HMA physical characteristics. Two different measures of densities are typically taken:

1) Bulk-specific gravity (G_{mb})
2) Theoretical maximum specific gravity (TMD, G_{mm}).

These densities are then used to calculate the volumetric parameters of the HMA. Measured void expressions are usually:

1) Air voids (V_a), sometimes expressed as voids in the total mix (VTM)
2) Voids in the mineral aggregate (VMA)
3) Voids filled with asphalt (VFA)

F. Optimum Asphalt Binder Content Selection

The optimum asphalt binder content is finally selected based on the combined results of Marshall stability and flow, density analysis, and void analysis.

IV. TESTING

Test on Bitumen Mix
1. Adhesiveness Test
2. Cohesive Test
3. Moisture Susceptibility Test

A. Adhesiveness Test

Adhesiveness is the bond between the patching mixture, the underlying pavement, and the sides of the pothole.

A few research center tests have been attempted with an end goal to produce an appropriate method to assess the adhesiveness of fixing materials. The shear test was led to assess the holding strength of fixing materials with old pavement yet the outcomes were uncertain (Prowell and Franklin 1996; Anderson et al. 1998). In this review, a test technique utilized by Virginia DOT for quality control of cold fixing material was embraced (Prowell and Franklin 1996). 500 grams of free asphalt blends were put in a 100-mm breadth Marshall form on top of a 75-mm test of compacted HMA and compacted with 10 blows of a standard Marshall hammer. The compacted test was expelled and the example was altered. The grip of the blend was estimated by the measure of time it took for example to drop from the substrate asphalt. Two gatherings of materials were tried, including the original and oven-aged (60C for 4 h) bunch. The test was led at room temperature (25C). During the test, it was observed that HMA had significantly longer bond time and accordingly the blow times for HMA were diminished to once and twice.

It is noticed that the adhesion time of cured cold bag blends was somewhere in the range of 20 and 30s, while that of the cured cold dump blend was around 50s.

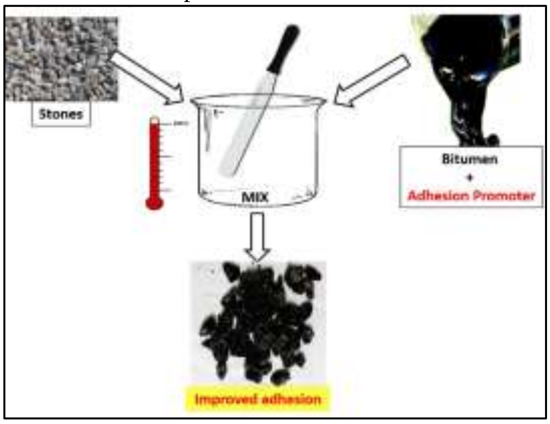

Fig. 2: Adhesive Test

B. Cohesion Test

In this review, fixed loose cold blends and the Marshall mold were set in a cooler at 4C for 12 h. A thousand grams of the cold blend were then positioned in the mold and compacted 5 times on each side with the Marshall hammer. The expelled sample was put in a 30.5-cm distance across full stature sieve with 25.4 mm (1 in.) openings. A cover was put on the sieve and the sieve was moved to and fro on its side around 550

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mm (22 in.) for 20 cycles. The suggested test time for this test is roughly 20 s (Tam and Lynch 1987). The sieve stayed in this situation for 10 s to let the loose material drop down. Then, at that point, the material dropped was determined by gauging the material held on the sieve. The level of materials held on the sieve was determined as a proportion of cohesion of the combination. A higher rate shows a more durable material. The Ontario Ministry of Transportation suggested a least rate held of 60% for sufficient cohesion in a cold blend. One constraint of this test is that it just shows the cohesion at low temperatures. The asphalt surface temperature could be a lot higher than 4C direct daylight even in winter. Accordingly, the test was likewise performed at room temperature (25C) with various compaction times to foster a methodology for portraying the cohesion at moderate temperature.

The tried samples can be grouped into good, moderate, and poor conditions. A good example had little material loss. The moderate samples had a moderate material loss yet at the same time keeping up with their geometrical shape. The poor sample completely self-destructed during the test and ordinarily had the level of material held lower than 60.

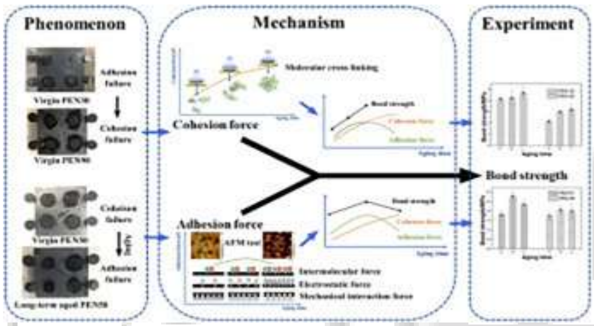

Fig. 3: Cohesion Test

C. Moisture Susceptibility

As per ASTM D4867, a moisture susceptibility test with freeze-thaw cycling was led to assess the freeze-thaw opposition of fixing materials. The fresh loose cold blend utilizing cutback asphalt couldn't be compacted into samples. To add solidness to the combination and mimic field conditions following a little while of traffic, the cold blends were relieved and matured before compaction in an oven at 60C for 96 h (Chatterjee et al. 2006). After restoring, the cold and hot blends were warmed to 100 and 135C, separately, to get ready 100-mm width Marshall samples. For the moisture susceptibility test, samples are generally compacted to avoid content somewhere in the range of 6% and 8%. Notwithstanding, because of the low-dense total degree, the void content of cold bag A and cold dump couldn't be controlled at 6 – 8% even with more compaction times. Past examinations observed that some cold-blend fixing material can have 10% air content even with 200 gyration times (Chatterjee et al. 2006). To recreate the real compaction of rehashed wheel loads in the field, samples were completely compacted for 50 blows on each side. The air content of cold dump, cold bag A, cold bag B, and HMA is 10.5%, 13.5%, 4.1%, and 0.95%, individually. The immersions were controlled between 70% also 80% as suggested by ASTM D4867.

The to some extent immersed examples were then wrapped with two layers of plastic film, fixed into a watertight plastic bag, set into a cooler at 278C for 20 h, and afterward at last inundated in a water shower at 608C for 24 h.

It very well may be seen that the overhauled TSR test separated the tried materials. HMA had the most noteworthy IDT strength, followed by cold bag A, cold dump, and cold bag B. The low strength of cold bag B is the primary driver of its high susceptibility to dishing in the field. The strength level of HMA was somewhere multiple times higher than those cold blends. Indeed, even after relieving at 60C for 96 h, the thickness of these cold blends may be still lower than that of the customary HMA and the low consistency and attachment caused deficient strength of the sample. Albeit the TSR of cold bag B was, showing the relieving impact of water shower, it had the most reduced elasticity. HMA had a TSR of 80%. The TSR of cold dump and cold bag A was, 80%, which was mostly brought about by the high air voids of the sample.

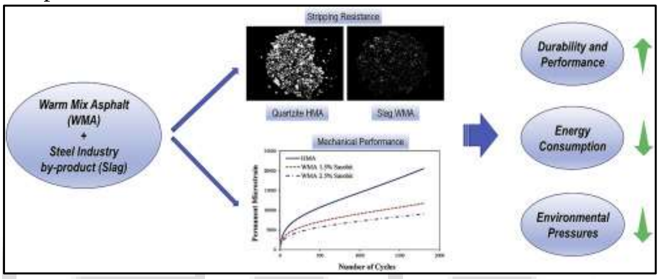

Fig. 4: Moisture Susceptibility

V. REPAIR TECHNIQUES

The most commonly used pothole filling techniques are:

A. Throw and Go
B. Throw and Roll
C. Semi-Permanent
D. Spray-Injection

A. Throw and Go

It is the most commonly used technique used to fill the potholes as it is quick and requires less cost. In this, the material is shoveled over the pothole, which may or may not contain water and debris, until the pothole gets filled. After that, the material is lightly compacted by shovel or it is left to get compacted by the traffic passing over it with time.

Fig. 5: Throw and Go

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B. Throw and Roll

It is an alternate technique that can be used instead of throw and go. In this technique, the pothole patching mixtures are shoveled into an unprepared pothole and compacted using the maintenance truck tires. The time required from the previous method is more but in the long run, this method is providing an increase in productivity as the materials are tightly patched.

Fig. 6: Throw and Roll

C. Semi-Permanent

The semi-permanent is considered as the best pothole patching technique that is useful for full depth replacement of an affected area. In this method, the potholes are first cleared of water and debris and the side of the potholes are squared to a depth where the pavement is sound. After that, the material is placed in the pothole, and the compacting equipment smaller than the diameter of the pothole is used such as vibratory plate compactor or single-drum vibratory rollers. By this method, the patching mix is compacted to an extreme extent and gives an extremely long life. The drawbacks of the method are that the labor required is high and the cost of repair is more.

Fig. 7: Semi-Permanent

D. Spray-Injection

The most useful kind of patching method for repairing transverse and potholes. First, the potholes are prepared by removing all the debris and water. Next, the asphalt and aggregate mix is sprayed into the pothole before being covered with another layer of aggregate. In this method, there is no need for any compaction, and high productivity can be achieved at the cost of increased equipment.

Fig. 8: Spray-Injection

VI. CONCLUSION

Based on research and investigation, The following conclusions can be made, and accordingly, materials and ways of pothole repair can be suggested. The formation of potholes is mainly due to delayed response to fix common pavement distresses when they develop in their initial phase. Traffic loads and moisture mainly lead to the formation of potholes by creating stresses. After the testing and the field evaluation the Hot Mix Asphalt performed better in terms of weather resistance, quick cooling down, strength, bend but not break. In the places where it is not suitable to use Hot Mix Asphalt, Cold Mix Asphalt is used. The Adhesion test is led at room temperature that is 25 degrees Celcius. and it was observed that HMA had significantly longer bond time and accordingly the blow times for HMA were diminished to once and twice. The adhesion time of cured cold bag blends was somewhere in the range of 20 and 30s, while that of the cured cold dump blend was around the 50s. when the moisture susceptibility test was done it was found that the strength level of HMA was somewhere multiple times higher than those cold blends.

The use of IOT's in place of conventional aggregates in pothole patching mixtures was tested and it was found that using iron ore tailings in the synthesis of pothole patching mixtures will help in the utilization of these wastes in great volume. The cost of repairing potholes can be reduced by 20-30%. The moisture of IOT's is more than the aggregates therefore workability of the mixture gets decreased by the addition of IOT's. The increase in cost strength also gets increased by 20-30% by the addition of IOT's.

REFERENCES

[1] Qiao Dong, Baoshan Huang & Sheng Zhao (2014). "*Field and laboratory evaluation of winter season pavement pothole patching materials*": International Journal of Pavement Engineering.
[2] Strategic Highway Research Program National Research Council(1992). "*Strategic Highway Research Program National Research Council*" Federal Highway Administration U.S. Department of Transportation
[3] Matthew Sainz (2016). *"Pothole Patching: A Review on Materials and Methods":* IAPA Scholarship Submission
[4] Tanuj Parmar, Prof. C.B. Mishra, Dr. Sangita, Prof. N.F Umrigar(2016). *"Potholes Repair Technology- A Review":* IJSRD

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