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Review of laboratory studies on performance of cold max asphalt using different additives

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ABSTRACT

In the current study, the focus was made on upgrading or modifying the cold mix asphalt (CMA) to a stage where the mechanical properties of CMA are comparable to traditional hot mix asphalt (HMA). Additives like cement and/or lime or waste materials (by-products) could be used within the mixtures to improve the mechanical properties, like indirect tensile stiffness modulus, resistance to permanent deformation, creep stiffness. Cold mix asphalt (CMA) with comparable engineering properties to hot-mix asphalt (HMA) is a breakthrough in laying of asphalt, particularly because these require no heat within the manufacturing and, the rutting and structural resistance to distress that occurs in road pavement and life span of pavements can indeed be enhanced. Many research projects have seen major developments in the hot laying process. The key goal is to create and refine a high-performance CMA mixture for use as a surface track that can be used in any scenario instead of hot mix asphalt (HMA). Because of these changes mix technology. Cold mix technology lags behind in both the fields of science and implementation, which is very evident in India. It is the main justification that underlies the option of the said CMA as current research area. In fact, this also provides benefits for the environment and economic benefits as compared to HMA.

Keywords: *Parking, City, Institutes, Disaggregate, Aggregate Model*

1. INTRODUCTION

1.1 General

Several roadbuilding proposals and events include mostlypavements with HMA. HMA, which is a rather traditional road building process, has for several years met the efficiency criteria in a structural way. The parameters the hot mix technology typically adopts are: Binding and aggregate drying, blending, tack grinding, blending, compaction phase accompanied by all performed at elevated temperatures between 120 ℃ and 165 ℃.While outcome-wise, this has become much appropriate for pavement structures, but their high usage has some limitations such as environmental deterioration, increased carbon in air, low manufacturing efficiency , low rain and cold weather laying job, restricted construction time within a year, oxidative binder stiffening, essentially managing health oflabors (Pundhir et al 2012). So, finding a reasonable replacement for the HMA is desirable.

In addition to this, in several northern and northeastern areas of India, such as J &K, rural road schemes involving huge economic burden are lagging. For these hilly areas, strong runoff, and woodland zones, it is challenging to operate with hot mix technologies due to topographical and environmental restrictions. Regardless of the topographical limitations, cold mix equipment is the only solution for ensuring research continues. The job is not compromised even under extreme climatic conditions as is the case for HMA. Within this article the innovations so far have been checked to see whether in the conventional methods of laying Asphalt we can create a substitute. Several study papers were reviewed to assess the efficiency of cold mix samples in order to see whether it is the substitution of standard hot mixes in places with topographical restrictions when operating historically. This study describes the need for creativity in renewable development as the need of the hour. However, it continues to see how studies have measured and validated a need for renewable technology advancement in the section of road building, thereby emphasizing the implementation of "natural highways" as a path towards sustainable growth. Green construction optimizes the usage of non-traditional road building products and techniques, and rising renewable resource use. It is about reducing the impact of traffic and infrastructure on sustainable society. The road-engineering industries will lead to environmentally sustainable (green) infrastructure through the design, installation and usage of materials. Cold mix technology is coming out in road construction as an environmentally friendly technology with the goal to go green. Cold Mix technology is an environmentally sustainable field implementation of mix architecture focused on cold mixing binders with the appropriate required IRC aggregates and mixing without the need for any heating.

In the emulsion-based cold mixing technology, all processes are done at room temperature by adding pre-wetting liquid to aggregate, after that adding emulsion to all of it, producing the mix, going to lay and compact. On top of that, research on fields have shown that the mixing can be easily produced using HMA to lay down using same procedures. It's work-friendly, too.

Uemura and Nakamori (1993) implemented the both experiments and ground experiments on CMA and reached the conclusion that CMA mixtures were more environmentally friendly due to the removal of smoke and exhaust fumes, as the aggregate and emulsified asphalt had to be not dried for mixture use. They also discovered that CMA performed at an appropriate standard.

Dittmar (2011) found how asphalt pavement fractures created in a cold mix were restored over time. He even suggested it'll last longer on roads having low traffic than HMA due to this versatility of the cold mix sheet.

Needham (1996) proposed creating cold mix for a variety of specific applications. Cold mixing can be used primarily as a base layer and seldom as a binder or wear layer. CMA may be added to self-contained mixing and laying plants via a range of ways varying from manual implementation to graders, finishers or pavers.

Oke (2010) indicated that among varied field compaction approaches, steel rolling seems to be the chosen process, preceded by a very strong pneumatic tyred roller and finished with steel rolling finish.

Most researchers in this field recommended that CMA is much more effective in energy consumption than hot mix asphalt. Several researchers in this field recommended that CMA is far very more effective than HMA in accordance with theefficiency of energy. In addition, Zoorob and Thanaya (2002) proposed CMA mixtures to be approved more widely for village and other district roads and where there is at most medium traffic. Cold mix is a combination of unheated aggregate and emulsion or filler or cutback. The key discrepancy between CMA and HMA is that aggregates and emulsions are mixed at ambient temperature (10 ℃-30 ℃) and cold mix scenario, while aggregates and binder are mixed at elevated temperatures (138 ℃-160 ℃) for HMA. Dense, graded cold mixtures have much less permeability and strong deformation tolerance. Free rated mixtures are storable and provide strong adhesion to semi dense mixtures

2. LITERATURE REVIEW

2.1 Introduction

Analysis of the literature on the field and laboratory studies conducted for CMA was discussed in this section. In contrast with HMA, few works were found in this area when the literature review was going through.

2.2 Bitumen Emulsion

Emulsion were first developed in the early 1920s, however, that emulsions, as we know today due to its eco-friendly behavior;& other advantages came to the notice. Detailed knowledge on bitumen emulsion has been presented in the transport study circular entitled "Asphalt Emulsion Technology" (TRB, 2006). An emulsion is the dispersion between one fluid's (liquid) tiny particles onto another. Emulsions may be produced by any two immiscible liquid phases and that usually a phase is water in several emulsions. It is a fluidsubstance wherein, in the presence of emulsifiers, a large volume of bitumen is dissolved in water in a finely separated shape. Used in maintenance of roads, bitumen emulsions can be defined as uniform mixture of tiny bitumen particles floating in continuous water medium.These forms of emulsions are commonly called as oil-in-water (o/w) emulsions. Emulsions typically contain asphalt cement, water and a chemical, surface-active emulsifying agent in rough proportion as follows: 61-68%, 29-33% and 1-5% respectively.Their process needs the use of a faster speed mechanical tool, such as a colloidal mill, that is high shear. In the contact with water as well as a chemical, surface-active emulsifier, the colloidal mill breaks down melted Asphalt into tiny particles. The emulsifier imparts its properties to the dispersed asphalt and has the greatest effect on preserving stable suspended asphalt droplet.Droplets of bitumen range between 0.1 and 20 microns in diameter.

2.2.1 Identification and names for emulsion: Emulsions are divided into three categories: anionic, cationic and nonionic. By practice, the former 2 forms are commonly used in road building and maintenance.The kind of emulsifier used in the bitumen emulsion decides whether anionic or cationic emulsion should be used. There are bituminous droplets with cationic emulsions that bear +ive charge. Anionic emulsions also performed badly on bitumen particles. Depending on its ability to set, showing how fast the water breaks out of emulsion, both cationic and anionic emulsions have been categorized based on their setting rate viz., rapid, medium and slow setting. The ability to set shall be governed by the emulsifying agent form and number. The key distinction among cationic and anionic emulsions has been that the cationic emulsion extracts liquid more readily than the anionic emulsion.Cationic RS, cationic MS and cationic SS emulsions were all represented in the taxonomy of emulsions as per ASTM (D977 and D2397) by that of the labels "CRS, CMS, and CSS" while anionic emulsions named RS, MS, and SS. All are accompanied by text and numbers which indicate the viscosity and residue properties of the emulsion.The use of cationic bitumen emulsion has been experiencing a steady increase in increasing requirement around globe including India. The INDIAN ROADS CONGRESS & MINISTRY OF ROAD TRANSPORT & HIGHWAYS suggested the use of Cationic Bitumen Emulsion in a variety of road construction applications, such as Tack Coat, Prime Coat, and Surface Coating, 20 mm Premix Carpet, Fog Seal Cracks etc.

2.2.2 Breaking mechanism of bitumen emulsion: The Cationic Bitumen is brown chocolate in color which flows freely at normal temperature. When the bitumen splits out and changes in color to black. It is said that an emulsion splits when the organic and the aqueous phase split into two independent layers, i.e., the dispersion stops. Macro emulsions are unstable intrinsically. The asphalt process must gradually detach from the water and this gradual time being hours to years. Asphalt is insoluble in mud, and emulsion breakdown requires droplet fusion (coalescence). The emulsifier is the purpose of the impact, as are the ionizable factors in the asphalt itself. Such tiny electrical interactions on the particlescommonlygrant an electrostatic shield to their closeness to one& other (such as repelling forces). But, when two particlesattainampleelectricity to overcome the impediment and methodcarefully then they bind (flocculate) to one another. The water sandwiched in between the dropletsthins over a length of time, and the particles coalesce. Factors that drive droplets together like gravity settling, evaporation, shear or freezing can expedite the process of flocculation and agglomeration

3. METHODOLOGY

So far, we have not one commonly known CMA design, and thus no golden law which must be observed.There is also no existing provisions or equipment explicitly meant to generate cold mixtures, thus the ones most commonly used for hot mixtures. The Marshall method used to design cold mixes has been popular. Thanaya also provided some modifications as was seen from the review. The comparison is given in table 2.2 below and MORTH specs for design of CMA.

Table 2.2 Comparative study between MS 14 and Thanaya CMA design procedure

AI MS 14 (1997)	Thanaya (2007)
<u>**Determination of**</u> ➢ Aggregate gradation (As per Specification) ➢ IRAC and IEC (As per formula) ➢ OPWC (Coating Test) ➢ OTLC (Dry Stability Test) ➢ ORAC (Dry Stability and Soaked Stability Test for each RAC)	<u>**Determination of**</u> ➢ Aggregate gradation (As per Specification) ➢ IRAC and IEC (As per MS 14 formula) ➢ OPWC (Coating Test) ➢ Compaction Level to achieve porosity target (Dry Stability Test) ➢ ORAC (Soaked Stability Test) ➢ Retained Stability (Dry Stability Test), AFT (As per formula) and Ultimate strength (fully cured mix) at ORAC

Table 2.3 Design requirements for CMA mix as per MORTH

Properties	Values
Marshall Stability	2.2 kN
Minimumflow	2 mm
Air voids	3 to 5 %
Maximum stability loss	50 %
Level ofcompaction	50 blows
Emulsion content	7 to 10 %
Voids in mineral aggregate (VMA)	BC: 14 %, SMA: 15%

3. CONCLUSION

oncluded that stiffness modulus in cold mix after modified with OPC was comparable to hot mix. But these engineering properties take some time to develop which is again rectified with the addition of OPC. OPC improves the early development of strength in such mixes. This improvement is because of the fact that the water remained after evaporation loss is used to hydrate the cement particles gradually increasing the stiffness of mix and, therefore, OPC acts as a binder in mix with appropriate water-cement ratio due to evaporation. This was proved by Scanning Electron Microscopy where it was seen that some of the OPC hydrates and becomes a part of the binder. Tests on calcium chloride and hydrated lime showed that these chemicals, as was thought, did not enhance the stiffness of the mix.

The key finding of the study, based on the different materials used, is that adding Ordinary Portland Cement to bitumen emulsion mixtures offers a general enhancement of mechanical properties to levels comparable to hot mix levels. Following conclusions are drawn from the above analysis considering efficiency of CMA:

- According to optimal analysis, what is found is that the early strength of the mix depends on the compacted mix's maximum total fluid content (OTLC). The healing time for achieving maximum strength of the mix is better at the same binder level having higher liquid volume. While it is challenging to obtain OTLC for field use, it can be extended to laboratory procedures to prevent delays in the research cycle. The definition has helped the present study's accepted architecture protocol.
- Increasing the degree of compaction is not found to be very successful in minimizing the air voids in CMA. In addition, the compaction degree is higher, and the complexity in field applications may be greater.
- The efficiency of mix modified with cement is witnessed to be advantageous in all aspects, although lime and cement have seen improvement in the stability value among the additives. Cement modified mix showed improvement of the engineering properties like indirect tensile strength and resilient modulus.

4. FUTURE SCOPE OF WORK

Below are several gaps of the present study and its potential future in this field.

- This research was confined to the design protocols adopted in MS 14 and only some investigators. Therefore, we should define other appropriate procedures.
- This cold mix research is focused primarily on Marshall Stability analysis, air void quality, indirect tensile strength and resilient modulus CMA. The efficiency qualities of mixing must be regarded in terms of several other engineering properties.

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