A REVIEW ON THE STUDY OF EFFECTS OF MODIFYING COLD MIX BITUMEN BY UTILISING VARIOUS METAL (STEEL AND ALUMINIUM) SHAVINGS AS REINFORCEMENT

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Abstract: The hot mix innovation has witnessed noteworthy progress through many routine research investigation programmes. On the contrary, the cold mix technology is lingering behind in both, assessment and in the fields of application, which is quite observational in emerging countries, such as India. This is the basic motivation behind taking up this field as current research area. Apart from it, it has a natural and economical preferred position over hot mixtures as it creates lesser pollution, and is therefore regarded as an eco-friendly technology. Presently, there is no globally recognized design procedure for cold mixtures. In the absence of any uniformity in the laboratory design methods of cold mixes that are followed by the different researchers/specialists/associations, it has become hard to frame the dependable relationships and to prepare a comparative analysis among the experimental outcomes revealed by them. Despite the fact that the emulsions based cold mixes overcome the conventional issues inherent in the hot mixes, they have pulled in little consideration, and are yet viewed as substandard as compared to hot blend in their utilization as structural layers mainly because of their less acceptable performance. In order to broaden cold mix applications, their methods of testing and specifications, this study needs advanced research studies and proper field examinations. The principle target of this investigation is the laboratory examination of the exhibition of metal shaving reinforced Cold Mix Asphalt (CMA) mixtures. These mixtures are additionally contrasted with traditional hot mix asphalt mixtures.

***Index Terms* – Cold mix, Additives, Metal Shavings, Cold Mix Asphalt (CMA), Optimum Emulsion Content.**

I. INTRODUCTION

Cold mix technology, which is usually emulsion based, the processes which include adding pre-wettings water to aggregates, incorporation of the emulsions to it, production of the mix, laying and the compaction, all are done at the room temperatures (23°C to 25°C). Moreover, various trials carried on field on mixes have also revealed that the cold mixtures can simply be manufactured by utilizing hot mix plants and can be placed by using same procedures. This technology has also successfully proved to be labor friendly.

In order to broaden cold mix applications, their methods of testing and specifications, this study needs advanced research studies and proper field examinations. Hot blend innovation has witnessed noteworthy advances by way of many research programs. However, Cold mix innovation is still lagging behind in both, research and application fields, something that is very noticeable in a developing country like India. In spite of various favourable circumstances over traditional hot blends, for example, this technique takes out heating of aggregates and binder, it is eco-friendly and saves energy consumption, much attention has not been paid towards it. Cold mix asphalt pavements can provide energy savings up to 50% in contrast to traditional hot mixes. So it tends to be considered as green bituminous mix for rural road construction and development. It may very well be effortlessly arranged utilizing a little set up nearby
. It may also be delivered physically for little scope work. This paving mix is especially appropriate for the development of roads in remote and disconnected territories of a nation where plant produced hot mix may have just set before arriving at the site. Moreover, the cold blend can be laid even during wet or climatic conditions. This is the essential inspiration behind taking up the study of coldimix technology as the current examination area.

The principal target of this investigation is the laboratory examination of the exhibition of metal shaving reinforced Cold Mix Asphalt (CMA) mixtures. These mixtures are additionally contrasted with traditional hot mix asphalt mixtures. Here, we attempt to undertake thorough literature survey on the various laboratory investigations that have so far been conducted with regard to the cold mix asphalt technology and analyse it in detail. This will give us a pretty good idea about the gaps present in the available literature so far and also how to proceed about our own research. While going through the literature review, barely any substantial works were seen in this field, in contrast with hot mix asphalts.

II. LITERATURE REVIEW

A) Use of Bitumen emulsion in cold asphalt

It has been found through the various researches and laboratory works that bitumen emulsion is ideal for the production of the cold mix that adheres to the aggregates effectively. A Transportation research circular entitled "Asphalt Emulsion Technology"

(TRB, 2006) provides necessary information with respect to the bitumen emulsion. An emulsion is defined as the dispersion of little droplets of one liquid in another liquid. Emulsions can be formed by any two immiscible fluids and yet in many emulsions, one of the phases is water. Bitumen emulsion is a liquid product wherein a generous quantity of the bitumen is suspended in a finely divided form in water in the presence of emulsifiers. The bitumen droplets extend from 0.1 to 2.5 % emulsifier, 25% to 60% water in addition to some minor products**.**

The kind of emulsifying operator utilized in the bituminous emulsion decides whether the emulsion finally will behave as anionic or cationic. Cationic emulsions possess the bituminous droplets that carry a positive charge, whereas anionic emulsions bear negative charge on bituminous droplets. In view of the setting rate, which shows how rapidly water isolates from rest of emulsion, both anionic and cationic emulsions are additionally characterized into rapid setting (RS), medium setting (MS), and slow setting (SS). The setting rate is essentially constrained by the sort and measure of the emulsifying agent. The foremost distinction among cationic and anionic emulsions is that the cationic emulsions surrender water quicker than anionic emulsion. According to IRC:SP-100-2014 distinct sorts of emulsions are RS-1, RS-2, MS, SS-1, SS-2.

B) Design method for the cold mix

The bituminous binders utilized in cold mixes are emulsified, hence are consequently in liquid state. In this way, it very well may be applied at moderately low temperatures in contrast with that of the hot mixes. Needham (1996) expressed that despite of the fact that cold mixes are commonly produced at ambient temperatures; a few procedures could likewise utilize the emulsions heated to around 60 degree celsius. Until now, there's is no generally acknowledged cold mix design procedure and consequently no thumb rules can be followed. Additionally there are no existing equipments made explicitly for the preparation and design of cold mixes, henceforth the methods already prevalent for thosesof hot mixes are most of the time employed. Marshall Technique has been commonly used to design cold mixes. Ministry of Road Transport and Highwayss (MORTH, 2013) specifications for Road and Bridge Work (Fifth Revision) presented the methods for bituminous cold mix design.These design guidelines are based on those of Asphalt Institute Manual Series14 (MS 14s).

C) Method and level of compaction

Thanaya et al (2009) inferred that on addition of cement to the mix, the cold mix ought to be subjected to compaction right after it is mixed so as to augment the outcomes and also to avoid issues relating to workability. On the contrary, if conditions do not permit this, then at that time, loose mixtures can be sealed in a compartment and then compacted after around 24 hours. Browns (1992) demonstrated that 75 blows of the Marshall compaction resulted in a huge damage to the aggregates especially in SMA mixtures.

Thanaya (2007) revealed that the utilization of a bulky compaction level is unavoidable in the cold mixes as the emulsion sets, consequently the mix undergoes solidification during the process of compaction. He additionally attempted to stimulate between Marshall and Gyratory methods of compaction listed as follows.

a) Medium compaction level: It amounts to 80 revolutions in the gyratory compactor and equals the amount of compaction effort generated when 50 blows are applied to every end of the sample by using a Marshall hammer.
b) Heavy compaction level: It amounts to 120 revolutions in the gyratory compactor and equals the amount of compaction effort generated when 75 blows are applied to every end of the sample by using a Marshall hammer.

C) Use of Additives in Cold mix

a) Cement: Schmidt et. al. (1973) examined the impact of the addition of cement to the mix in an attempt to improve the slow advancement of strength characteristics of the emulsion-treated mixes. Addition of cement to the aggregate was made at the moment the asphalt emulsion was fused in. On studying, it was indicated that mixes which were treated through this way cured quicker, built up a high resilient modulus (M_r) quicker, and were increasingly impervious to water harm. Terrel and Wang (1971) recently indicated that pace of improvement of M_r in emulsion-treated mixes was incredibly quickened on adding cement. Head (1974) reported the after effects of exploration on the cement modified asphalt cold mixes. He showed that addition of the cement had an exceptionally noteworthy impact on mix stability and that the application of 1% cement developed an enhanced stability of 250-300% over that of untreated samples. Samples without cement submerged in water after stability tests broke down following 24 hours, while cement-treated samples showed no disintegration. Uemura and Nakamori (1993) detailed the utilization of typical Portland cement in the emulsion mixtures for a considerable length of time in Japan. Li et al (1998) led analyses to assess the mechanical properties of a three-stage cement-asphalt emulsion composite (CAEC). Through trial examination, they detailed that CAEC had the vast majority of the characteristics of both, cement and asphalt, specifically the greater fatigue life and reduced vulnerability to temperature of cement concrete, and more toughness and flexibility of asphalt concrete. Brown and Needham (2000) showed that cement caused emulsion charges to turn out to be increasingly positive (or more positive). Pouliot et al. (2003) planned for understanding the hydration procedure, the microstructure, and the mechanical properties of mortars prepared with another mixed binder made of a cement slurry and a little amount of an asphalt emulsion (SS-1 and CSS-1). They demonstrated that the cement hydration process was ostensibly affected by presence of a little amount of emulsion. Song et al. (2006) purposed to assess the achievability on the utilization of an asphalt emulsion as a polymeric admixture. They indicated that waterproofness, carbonation resistance and chloride-ion penetration resistance of the asphalt-modified mortars were uniquely improved with the expansion in the polymer-cement proportion, while their compressive strength and adhesion to mortar substrates were decreased with the expansion in polymer-concrete proportion. Oruc et al. (2007) led analyses to assess the mechanical properties of emulsified asphalt mixtures having Portland cement fill in for mineral filler in an expanded rate from 0-6%. The test outcomes represented huge improvement with a high Portland cement percentage and demonstrated cement was an effective adhesive agent for emulsion mixtures. In addition they also recommended that the cement modified asphalt emulsion blends may be utilized as a structural pavement layer. Thanaya et al. (2009) detailed that addition of 1-2% of rapid-setting cement accelerated the early strength acquired just as upgraded the mechanical performance of the modified cold mixes.

b) Fly ash: Fly ash is utilized as a filler material. Customarily, fly ashes have been utilized in a scope of operations, in particular as fill materials, for grouting, and soil stabilization. Thanayas et al. (2009) illustrated the experiments and their results derived from addition of coal combustion remains (ashes) into the cold bituminous emulsion mixtures (CBEMs). The coal debris utilized was fly ash that was utilized as filler material in CBEMs. The properties that were assessed were: volumetric properties, repeated load axial creep, and stiffness modulus (ITSM). The said attributes were contrasted with conventional cold asphalt mixtures that did not contain any of the reused materials. Fly ash was seen as entirely reasonable for its usage as filler in cold bituminous mixtures. At the complete curing conditions, rigidity of CBEMs was seen as truly equivalent to that in hot mixtures. Al-Busaltan and others (2012) utilized LIMU-FA1 which was a local, waste fly ash, inside CBEMs to augment the mechanical properties, in particular Indirect Tensile Stiffness Modulus and Creep Stiffness. Varying amounts of the particular material from 0.5 to 5.5 % of the aggregate content in the mixture was included in CBEMs. The outcomes showed a proportional improvement in mechanical properties of resulting mixtures. Asi and Assad (2005) examined the impact of Jordanian oil shale fly ash on asphalt mixes. It demonstrates that oil shale fly ash modification ameliorated the resilient modulus and dynamic creep test results of the altered mixes when contrasted with the control mix.

c) Lime: Wang and Sha (2010) in an investigation demonstrated that the limestone and its fillers influence upon performance of cold mix asphalt mixtures was noteworthy when contrasted with granite and granite fillers

d) Fiber: G. Ferroit (2014) examined the impact of expansion of three kinds of fiber (cellulose, glass-cellulose, nylon-polyester-cellulose) on the mechanical properties of high performance fiber fortified cold mix asphalt mixtures. The outcomes demonstrated the improved performance of fiber fortified asphalt. Hayder Kamil Shanbara (2018) contemplated the impact of natural and synthetic fibers on mechanical properties of high performance cold mix asphalt. The outcomes indicated the improved tensile strength. The improved exhibition of the strengthened mixtures encouraged a substantially lower permanent deformation than conventional mixtures. Benedito et al. (2003) examined the impact of the expansion of polypropylene fiber on the mechanical properties of dense graded cold mix asphalt mixtures. The outcomes demonstrated that the incorporation of fiber was liable for a little variation in mixture strength parameters, as well as for significant drops in mixture resilient moduli when contrasted with plain mixtures.

e) Chemical Products: Suliman and Awwad (2000) utilized the oil shale as expander to the asphalt cement. The shale oil binders showed conflicting physical properties, which could be credited to the incongruence of the oil shale with the asphalt cement because of inappropriate mixing of oil shale with the asphalt cement. Edwards et al. (2006) examined the impacts of commercial waxes on asphalt concrete mixtures. The outcomes (dynamic creep test) demonstrated that the littlest strain was recorded for the asphalt mixtures with bitumen containing commercial waxes, showing better protection from rutting. Chavez-Valencia, Alonso, Manzano, Prez, Contreras and Signoret (2007) demonstrated that when bitumen emulsion was modified with the solution of of polyvinyl acetate emulsion (PVAC-E), it shows a substantial increase in the compressive strength of the cold mix, thus a pavement made by this modified cold mix could demonstrate improved protection from the rutting and fatigue brought about by the substantial traffic loads. Borhan et al. (2009) led an experiment to assess the utilization of used cylinder oil (UCO) in the preparation of asphalt concrete. The mechanical properties of the modified asphalt mixtures were analyzed and contrasted with a conventional mixture. The physical properties of UCO were first investigated. Various percentages of UCO (0%, 5%, 10%, 15% and 20%) were utilized as solvent material for the preparation of asphalt concrete mixes. Every specimen was tried for Marshall Stability, Indirect tensile strength, Abrasion resistance and static and dynamic creep. The incorporation of UCO was seen to mellow the asphalt-UCO binders. The outcome showed that the impacts of UCO in asphalt concrete mixes relied upon the percentages of UCO utilized in the blends and furthermore on the chemical interaction between the UCO and the asphalt.

III. CONCLUSIONS

From the audit of literature work, it can be observed that the mechanical properties of cold mixtures are influenced by various number of parameters; including aggregate gradation, the type of emulsion, level of compaction, void content, curing time, percentages and type of additives, for example, cement. In spite of the fact that mechanical properties of the cold mix asphalt mixtures can be visibly improved by fusing cementitious material, for example, Ordinary Portland cement and rapid setting cement, yet tragically, these materials are charged at extra cost and also leave a significant $C0_2$ impact on the surroundings. Along these lines, endeavours ought to be made to address some practical and increasingly ecologically well-disposed materials using the waste or by product.

No generally acknowledged mix design procedure is accessible till now, rather a bunch of methodologies have been created by nations and agencies to suit their local conditions and needs. The design strategy should aim at determining the most appropriate gradation for aggregates, the optimum bitumen emulsion, the pre-mix water content, and the most suitable compaction method for the design mix. The design procedure given in IRC: SP: 100-2014 was utilized to conduct this study.

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