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Improvement in Recycling of Reclaimed Asphalt Pavements using Different Materials in Flexible Pavement

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Abstract:
This paper aims to study properties, strength, advantages and disadvantages of RAP (Recycling of Reclaimed Asphaltic Pavement) using different materials in flexible pavement. This is a Cold-in-Place Recycling (CIPR) method for flexible pavements. This was experimented on the base course of pavement by replacing the WMM (wet mix macadam) layer of Flexible Pavement which is non bituminous. This method has various economical and environmental advantages whichinvolve the recycling of existing road surface aggregates and reduced haul requirements for incorporating new aggregates. By recycling existing in-place road materials and providing additional strength with mixing of different emulsions or strengthening agents, new aggregates and bitumen requirements are reduced. Various Laboratory tests were conducted by using different binding materials and different materials like cement , fly ash , lime , fibre (Recron 3s Fibre).

I. INTRODUCTION

Recycled asphalt pavement (RAP) has increasingly been used as a base material for highway construction as a sustainable solution. Due to the existence of asphalt, 100 % RAP typically has low strength and high potential of creep and permanent deformations. RAP can be blended with virgin aggregate, stabilized by cement fly-ash lime or fibre to increase its strength and reduce its creep and permanent deformations. Asphalt pavements which have reached the end of their service life are frequently rehabilitated by milling the existing pavement surfaces and replacing the milled portion with new hot mix asphalt (HMA). A large amount of recycled asphalt pavement (RAP) is generated every year because of this practice. The use of RAP has been in practice since 1930s and is necessary to reduce the cost of construction materials, to reduce the use of petroleum-based products, and to conserve natural resources by requiring less virgin aggregate and asphalt in road construction projects. RAP can be used as a granular base material in paved and unpaved roadways, parking areas, bicycle paths, gravel road rehabilitation, shoulders, residential driveways, trench backfill, engineered fill, and culvert backfill. Currently, great emphasis is placed on sustainable construction and infrastructure because the demand for sustainable and environmental friendly roads is increasing. More green technologies for sustainable roadway construction are needed. One way to construct environmentally sound roads is through the use of RAP materials. Historically, RAP has been used with new bituminous materials by either a hot-mix or cold-mix recycling process. However, a large quantity of RAP materials remains unused. Recent investigations have shown that the waste problems can be reduced by using RAP as base and subbase aggregate materials. Using RAP as a base course material would preserve non-renewable aggregate as well as reduce the amount of space needed to store millions of tons of RAP created each year. Literature indicates that 100 % RAP could not produce base course of high quality due to its significant rate dependency and high deformation and creep. Several researchers have suggested that high-quality base courses could be obtained by blending RAP with virgin aggregates, stabilizing RAP with chemical additives such as cement, lime, fly ash, fibre. Fly ash is a fine, glass-like powder material recovered from gases created by coal-fired electric power generation. Millions of tons of fly ash were produced by INDIAN power plants annually. Stabilizing RAP with fly ash is an attractive and sustainable solution because fly ash traditionally has been disposed in landfills. Stabilizing RAP with fibre such as Recron 3s is also a option to be considered. Recron 3S Fibre is a modified polyester fibre. It is generally used as secondary reinforcing material in concrete and soil to increase their performance. Use ofRecron-3S as a reinforcing material is to increase the strength in various applications like cement based precast products, filtration fabrics etc. It is a reinforcing fibre that improves properties such as tear, tensile, burst and bulk.

II. KEYWORDS OF THE PROPOSED EXPERIMENT

Here we will be discussing the major keywords used the paper.

A. Recycling of Reclaimed asphalt pavement (RAP)

Recycling of Reclaimed Asphalt Pavements (RAP) must be used for technical, economical, and environmental reasons. Use of RAP has been favoured all over the world over virgin materials in the light of the increasing cost of bitumen, the scarcity of quality aggregates, and the pressing need to preserve the environment. The use of RAP also decreases the amount of waste produced and help store solve the disposal problems of highway construction materials. Reclaimed Asphalt Pavements contain best quality aggregates and they can be effectively improved with foamed asphalt/bitumen emulsion along with/without fresh aggregates and crusher dust to impart necessary strength for durable pavements. If only the surface layer is weathered or damaged, hot recycling can be an attractive proposition. Several recycling techniques, such as hot mix plant recycling, hot in-place recycling, cold mix plant recycling, cold in-place recycling, and full depth reclamation, have evolved over the past 35 years. In-place recycling not only reduces the use of new materials but also reduces emissions, traffic, and energy associated with the transport and production of these materials. Hot Mix Recycling is the most common method of recycling asphalt pavements in developed countries. It involves combining RAP with new or virgin aggregate, new asphalt binder, and recycling agents in a central hot mix plant to produce a recycled mix. The amount of RAP allowed in a recycled hot bituminous mix as per different guidelines varies from agencies to agencies. Cold Mix Plant Recycling is a method of recycling where RAP and emulsified bitumen or foamed bitumen are mixed cold in a centrally located cold mix plant. Many old road alignment having thick bituminous layers are being abandoned in four and six lane projects and the entire RAP can be salvaged by milling machine and reused in new construction. Even cement treated aggregates have been milled and reused in USA, South Africa and China. Since the components of a cold mix plant are fairly portable, it can be assembled in satellite locations close to a project site. Cold recycled mix is hauled to the job site with conventional dump trucks or belly dump trucks. Placement and compaction of cold recycled mixes are done with the same conventional pavers and rollers used for hot mix asphalt construction. Cold recycled mixes are normally overlaid with hot mix asphalt or surface dressing (chip seal) depending on the anticipated traffic level for the finished pavement.

B. Recron 3s fibre

Research and development work in Fibre Reinforced Concrete (FRC) composites began in India in the early 1970s. fibre reinforced concrete was developed to overcome the problems associated with cement based materials such as low tensile strength, poor fracture toughness and brittleness of cementations composites. In the beginning, FRC was primarily used for pavements and industrial floors but now a day FRC composite is being used for a wide variety of applications including bridges, tunnel and canal linings, hydraulic structures, pipes, safety vaults and structural members.

There are so many type of polymer fibre available as secondary construction materials, The Recron-3S fibre is one of them, and The Reliance Industry Limited (RIL) has launched Recron-3S. Recron-3s polymer fibre for mixing concrete and mortar for improving certain properties of the concrete and mortar. Fibres have special triangular shape for better anchoring with other ingredient of the mix. Recron-3S fibre is available in 6mm and 12mm length.

III. Experimental Method and its Methodology

A. Cold in place recycling (CIPR):

It involves rehabilitation of the existing asphalt or granular road surface. The existing surface is pulverized and the material is mixed on the site with foamed bitumen or bitumen emulsion. The process of in-situ recycling of distressed pavement using cold- mix technology is referred to as cold in-place recycling (CIPR). CIPR thus is a pavement rehabilitation measure that typically consists of the following operations, Often all are carried out in one-pass of a recycling machine and a badly distressed pavement is transformed into a stronger good looking pavement.

1. Milling the existing pavement layers up to a depth of 300 mm;
2. Treatment with bitumen emulsion or foamed bitumen, often in combination with addition of crusher dust, fresh aggregates if required, and a small percentage of active filler such as cement , lime , fibre etc.
3. Adding compaction water; and
4. Repaving the mix.
5. Compaction with a pad foot roller when the compacted thickness exceeds 150mm.

In a CIPR process as described above, the top bituminous layer (Reclaimed asphalt pavement) as well as a part or whole of the granular or stabilized base layer are recycled. The residual binder content added to the mineral aggregates in the process of CIPR is generally lower (<4 per cent) in comparison to hot bituminous mixtures. The recycled product is not used as final surfacing layer but used as base or sub-base layer.

B. ADVANTAGES OF C.I.P.R.

CIPR is an attractive alternative for highway rehabilitation operations because of its economic and environmental advantages. Major economic advantages involve the recycling of existing road surface aggregates and reduced haul requirements for incorporating new aggregates. In India, there are many regions where aggregates resources are limited or will be depleted in the near future. Aggregate haul in these regions is quite expensive. In addition, impacts on adjacent haul roads are minimized or eliminated because of reduced new aggregate requirements. A major environmental advantage involved in the use of cold in-place recycling is that there is no requirement for heat during construction work. CIPR is an energy efficient process that does not produce harmful emissions and does not require the bituminous mixtures to be transported to an off-site plant. In addition, transportation of large amounts of aggregate are reduced and hence it is fuel efficient also.

C. EXPERIMENTAL METHOD

In this study, the major test conducted will be Marshall test and Indirect tensile strength test (ITS). A number of combination of materials and binders will be studied.

Variations with SS_2 as binder			
R.A.P.	Fresh aggregate	Emulsion – SS_2	Cement – OPC 43
R.A.P.	Fresh aggregate	Emulsion – SS_2	Fibre – Recron 3s
R.A.P.	Fresh aggregate	Emulsion – SS_2	Hydrated Lime
R.A.P.	Fresh aggregate	Emulsion – SS_2	Fly Ash

Variations with Old Engine Oil as binder			
R.A.P.	Fresh aggregate	Old Engine oil	Cement – OPC 43
R.A.P.	Fresh aggregate	Old Engine oil	Fibre – Recron 3s
R.A.P.	Fresh aggregate	Old Engine oil	Hydrated Lime
R.A.P.	Fresh aggregate	Old Engine oil	Fly Ash

IV. CONCLUSION

The results of the test conducted for the first combination i.e. the combination of RAP with cement and emulsion SS_2 are following:
ITS_{dry}: 264.67 kPa
$ITS_{wet:}$ 201.53 kPa
Marshall $_{dry}$: 16.94 KN
Marshall $_{wet:}$ 10.20 KN
The values mentioned above are the average of three values for each test. The results of the Marshall and ITS test mentioned above will be compared with all the other combinations in this study. Also this study will determine which of these combinations are passing the required parameters and whether they are economical for practical use.

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