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New Technologies in Bituminous Pavement Construction

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Abstract - *Mobility of people and goods has been a primitive and everlasting need through the centuries. Mankind has been compelled to move from one place to another in a continuous and persistent struggle to survive. Either for hunting and exploring new land or for chasing enemies and shifting shelter, mankind has been driven to draw and construct safe and secure track ways, developing gradually, through the years, to stone roads and later on, to modern highways and smart roads. There chronological technological development in pavement construction around the globe including India.*

Key Words: Bituminous Pavement, RAP, Plastic Waste, Cold Mix, ETA, CTA, Nano Technology

1. INTRODUCTION

Thus India has a big road network, out of which maximum length is Flexible Pavement i.e. have Bituminous Layers which required financial and technical attention to manage and maintain this network along with construction of new roads. Development of new technologies not only in India but worldwide have some common goal like economy, durability, transportation facility, environmental protection, conservation of natural resources and overall sustainable development. New technologies in road construction are implemented in terms of smart construction techniques, modern machinery, smart materials and enhanced design methodologies etc. There are number of modern technologies used in bituminous highways construction but here we have some brief discussion of those which are relevant to Indian scenario.

2. HISTORY OF ROAD DEVELOPMENT

Looking back to the history of roads, it is clear and discernible that technological development, but also every extension of the pre-existing network, took place under stable social conditions, especially during flourishing states: Persian reign, Roman Empire, Byzantine Empire. As India is concerned there is chronological development in Road Technologies, starting from Indus Valley Civilization (2600-2800 BC). Kautilya (350-275 BC), the great administrator of that time and the author of Arthasastra, laid down the standard widths of various classes of roads. During Mauryan Emperors (321-185 BC) was a period when Ashoka (268-232 BC) and others initiated in this direction. Sher Shah Suri (11472-1545 AD) a Pashtun Monarch also have a great contribution during a short period (1540-1545AD).

The period covering decline of the Mughals and the beginning of the British rule was a period of neglect of road system in India. Only William Bentinck and Lord Dalhousie took some steps to improve the roads. Post independence development of Indian road network accelerated by Nagpur Plan (1943-1961), Bombay Plan (1961-1981), Lucknow Plan (1981-2001) and finally in running Road Development Plan Vision (2001-2021) . Present Indian road network have total road length 62,15,797 km which incorporated 1,36,440 km National Highways/ Expressway, 1,76,818 km State Highways and 59,02,539 km Other Roads .

3. MODERN TECHNOLOGIES

3.1 Reclaimed Asphalt Pavement (RAP):

RAP is removed and reprocessed deteriorated bituminous pavement materials during recycling of bituminous pavement. Recycling is defined as "the reuse, usually after some processing, of a material that already has served its first-intended purpose". The bituminous pavement rehabilitation alternatives are mainly overlaying, recycling and reconstruction. In the recycling process the material from deteriorated pavement, known as Reclaimed Asphalt Pavement (RAP), is partially or fully reused in fresh construction. Pavement recycling came in discussion in USA in 1st time. Presently it is implemented worldwide. Pavement recycling technique is an excellent way of rehabilitation of deteriorated pavements. Recycling may use to overcome problem of depleting natural resources, unwanted increases of road elevation due to periodical overlay (specially with the city roads) and disposal problem of scraped bituminous layers. Some other advantages associated with pavement recycling are less user delay, conservation of energy, preservation of environment, reduced cost of construction, conservation of aggregate and binder preservation of existing pavement geometrics etc. Indian Road Congress have Introduced "IRC-120-2015- Recommended Practice for Recycling of Bituminous Pavement". Guidelines of use of reclaimed asphalt pavement (RAP) is also given in "IRC-37-2018- Guidelines for the Design of Flexible Pavements (3rd revision)".

3.2 ETA and CTA:

These are two new methodology introduced with or without RAP as stabilized base construction which reduced thickness of flexible pavement hence reducing finance involved, natural recourses and carbon emission (foot print) hence environmental friendly. Here ETA stands for Emulsion Treated Aggregate and CTA stands for Cement Treated Aggregate. Guidelines given in "IS: 2386(Part 4) are helpful in selection of aggregates in application of ETA and CTA technologies".

3.3 Use of Plastic Waste Materials in Bituminous Mixes:

It is another technology used in road construction. The waste plastic and its disposal is a major threat to the environment, which results in pollution and global warming. The utilization of plastic waste in bituminous mixes enhances its properties and also its strength. In addition it will also be a solution to plastic disposal & various defects in pavement viz., pot holes, corrugation, ruts, etc. the waste plastic used are poly-ethylene, polystyrene , polypropylene. The waste plastic is shredded & coated over aggregate & mixed with hot bitumen and resulted mix is used for pavement construction. This will not only strengthen the pavement and also increases its durability. In India Use of plastic waste are in initial stage. MORTH, NHAI, NRRDA and different State Governments including Uttar Pradesh have taken steps towards implementation of this technology. Indian Road Congress published "IRC: SP: 98-2013 Guidelines for The Use of Wastes Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses" in this regard.

3.4 Cold Mix Technology:

It is a recent technology gaining popularity in road construction industry. In India for decades Hot Mix Asphalt with bitumen aggregate has been used as Pavement mixes. The wide use of hot mix technology leads to environmental pollution as these plants emit a huge amount of Greenhouse gases. Hot Mix Asphalt also works favorably with certain environmental conditions. These plants are sometimes purely nonfunctional at the time of rainy season. Cold Mix on the other hand is a pavement technology without heating the aggregates using cationic bitumen emulsion. The usage of Cold mix bitumen Emulsion in India is a sustainable technology and ideal for India as use of bitumen emulsion negates the heating of aggregate and binder. Aggregates are made wet with water and then further coating of bitumen emulsion is done. Advantages of Cold Mix over traditional Hot Mix Asphalt includes ,no need of maintaining high temperature while manufacturing and laying the mix, Pollution free environment, low risk for the laborers as the working conditions are not extreme, favorable to work in all different weather conditions, Energy savings as no heating required. Cold Mix Bitumen Emulsion is ideal for remote locations and rural areas. The Central Road Research (CSIR-CRRI) is the organization in India which carries research and development activities for safely construction of roads including cold mix technology. Indian Road Congress published "IRC: SP: 100-2014 Use of Cold Mix Technology in Construction and Maintenance of Roads Using bitumen Emulsion" as guidelines for this technology in India.

3.5 Nano- Technology in Road construction:

It is a modern technique to enhance the water susceptibility and stripping properties in bituminous road construction. To enhance the strength and durability of flexible pavement innovative chemical agents are gaining popularity developed with adds of nano technology. Nano technology provides innovative Bitumen Additives that chemically enhance the bonds between the asphalt binder and the aggregate while also reduced water susceptibility of bituminous mixes. Nano technology additives helps to work at lower temperature with same or superior quality of hot bituminous mixes, thus it is energy efficient. In cold mix asphalt application nano technology enhanced bonding of aggregate and bitumen in same layer along with strong bonding between two adjacent layers by creating bonding membrane between the aggregates and the pavement layers. Requirement of asphalt binder reduced by this technology and it also reduce wastage of binder by tire pick up. Nano technology also used to enhance the soil stabilization, dust control, soil bases impermeability and expansivity of the base; thus making pavement dimensionally stable. some Nano Materials creates strong inter-particle bonds which when coupled with the water resistant nature of the base, means an immensely strong and self-strengthening base. "IS: 1492-2017: Anti- Stripping agents for Bitumen addition- Specification (First Revision)" is a primary guideline during selection of Nano Materials.

4. CONCLUSIONS

As discussed above these are few technologies growing and gaining popularity in highway industry. Selection of appropriate technology depends upon local requirements, financial availability, natural resources, technical support and environmental aspects also. While selecting any technology Sustainability of development should be utmost priority.

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BIOGRAPHY

Anil Kumar Yadava completed his graduation B.Tech. in Civil Engineering in 2003 from *Institute Of Engineering And Technology, Lucknow (U.P,, India)* ,a reputed Government Engineering College situated in state capital of Uttar Pradesh. He pursued M.Tech. in Geotechnical Engineering from well known institution *Motilal Nehru National Institute Of Technology, Allahabad (U.P., India)* . After completing Master Degree author started his carrier as Assistant Professor in Department of Civil Engineering in Integral University, Lucknow (U.P., India).In Integral University he taught Geotechnical Engineering & Transportation Engineering along with Laboratory Establishment and several other Academic and Research activities. After Integral University author joined *Public Works Department Uttar Pradesh* as an Assistant Engineer and presently working in this department. He had worked on deputation as Assistant Engineer in *U.P. State Bridge Corporation Ltd*. a reputed Public Sector Organization of State of Uttar Pradesh. Till now during his carrier as a Government Engineering Officer he executed more than 20 major Bridge Projects and More than 30 Major Road Projects. Presently He is completing his Ph.D. degree in Integral University and authored five papers in reputed journals and presented one paper in International Conference. Author is Associate Member of American Society of Civil Engineers (ASCE) and Member of Indian Road Congress (IRC).