AN IMPROVING PROPERTIES OF WET MIX MACADAM (WMM) USING INDUSTRIAL WASTE – A REVIEW

[1]Ashish. V. Zade, [2]Abhijit N Bhirud,

[1] P.G. Student, [2] Associate Professor,

[1,2] Department of Civil Engineering,

[1,2] JSPM's Imperial College of Engineering & Research, Wagholi, Pune, Maharashtra, India.

Abstract: The Ferromanganese Slag contains substantial volume of Iron and Manganese and the content is mainly in silicate phases which makes the material hard and durable. A high-quality silica sand commonly known as Foundry sand that is a derivative from the manufacture of both nonferrous and ferrous metal castings. It is a waste material daunting hazardous effect on environment and human health. Its disposal is not economically viable and cannot be disposed freely in nature. The integral properties of foundry sand could be utilized to make this material as environmentally friendly and resolve the problem of its disposal. Similarly, tyre chips are industrial wastes which can be reused. This project discusses about the improvement of Wet Mix Macadam properties of flexible pavement by blending the mix with foundry sand tyre chips and Ferromanganese Slag. The influence of diverse mix proportions of aggregate, stone dust, Foundry sand, Ferromanganese slag and tyre chips on Maximum Dry Density (MDD), permeability and California Bearing Ratio (CBR) values has been studied. The reports demonstrate that with adding Ferromanganese slag, foundry sand and tyre chips in W.M.M, the value of CBR and the Maximum Dry Density (MDD) of the mixture substantially increases. The designed mix with optimum percentage of aggregate, stone dust, foundry sand Ferromanganese slag and tyre chips can be effectively used in building the base layer of flexible pavement thus presenting a solution to construct good roads at low cost.

Index Terms **- Ferromanganese slag, Foundry Sand, Tyre Chips, Wet Mix Macadam, Flexible Pavement.**

I. INTRODUCTION

For the road construction soil, sand, stone aggregate, bitumen etc. are used traditionally. These natural materials of exhaustible nature and the quantity of these materials is reducing gradually. Due to gradual reduction in quantity of good quality material cost of natural material is growing. After observing this, the scientists are beholding for substitute materials for highway construction. For highway construction industrial waste materials is one such type which can be exploited as alternative material. Proper utilization of these materials in highway construction may partly reduce the disposal and pollution problems. Without the presence of other outlets, this solid waste occupies a vast area of land around the industrial plants throughout the country. After formulating necessary specifications several attempts are made to make the most of the consumption of the solid wastes in road pavements into its diverse layers.

In recent years, many developing and industrialized countries have been applying industrial wastes in building roads with great interest. The material consumption in the process is based on economical, technical and biological criteria. The deficiency of natural road materials and the protection for the environment makes it domineering to examine the possible usage of these materials carefully. India has a large network of Industries located in different portions of the country and many more are planned for the future. Millions of metric tons of industrial wastes are byproduct in these establishments.

Various industrial waste materials are disposed into uncontrolled pits and consuming large amount of land throughout the country. So, our emphasis is that use these industrial waste materials in road making by using economic, technical and ecological criteria's. Hence it is an appropriate to test these industrial waste materials and to develop specifications to improve the usage of these industrial waste materials in road making, in which higher economic returns are possible. The necessary specifications and criteria should be formulated to make best use of the usage of these industrial waste materials in road pavements into its different layers.

II. PROBLEM STATEMENT

While constructing the W.M.M layer crushed stone aggregate and stone dust used as ingredients. These ingredients are costly so to reduce the cost of W.M.M the waste material such as tyre chips and foundry sand can be utilized in W.M.M mix. The total replacement of aggregate is not beneficial because of its physical property. So, to avoid these problems stabilization is the option. These scrap materials having high impact on nature so to reduce the impact these materials are used as ingredient in W.M.M. This project aims to reduce the cost of W.M.M by taking care to maintain desired quality with respect to strength and function.

1.1 Introduction to Wet Mix Macadam

The Wet Mix Macadam is a layer component of the pavement in which graded crushed aggregates and granular material, mixed with water in a mixing plant and rolled at site into a dense mass on a pre-prepared surface. The advantages of WMM over WBM include proper gradation of aggregate, rate of construction is fast, denser mass that can be attained, fewer consumption of water. The specification can be implemented for base and sub-base courses. The work can be accomplished in layers. The individual thickness of a sole layer should not be less than 75mm and can be up-to 200 mm provided suitable type of compacting equipment issued.

1.2 Introduction to Foundry Sand

The Foundry sand is primarily fine aggregates and can be used as an alternative to the natural or manufactured sands. This may include usage in the embankments, flow-able fills or in the Portland cement concrete (PCC) and the hot mix asphalt (HMA). Foundry sand is typically round in shape to sub angular. After being utilized in the foundry process, a substantial number of sand clusters are

formed which are further broken down, the shape of the individual sand grain is deceptive. Foundry sand has the same properties as that of natural sands. The Classifications of the foundry sand may depend upon the different types of binder (bentonite or resinous).

1.3 Introduction to Tyre Chips

The tire composition varies by manufacturer and type. Automobile tires are made of natural rubber, synthetic rubber elastomers, polymers, and other additives. Steel reinforcing is also provided to improve strength. Tires are intended to endure the rigidities of the environment so that they are durable and safe when used on a vehicle. Even the discarded tires maintain their chemical composition, requiring hundreds of years to fully decompose (Hoffman, 1974). Over 280 million tons of scrap tires are generated per annum in the United States. In addition, 2 to 4 billion scrap tires are stock-piled across the country, and these stock piles pose health and fire hazards, and they are aesthetically unpleasing. Therefore, the reuse of huge amounts of scrap is advantageous, and several researchers have dedicated their attention towards the use of scrap tires for environmental and civil engineering applications. One of the usages is the utilization of the shredded scrap tires in landfill cover as a drainage material.

1.4 Introduction to Ferromanganese slag

Ferromanganese production led to the creation of slags as a byproduct, which contain substantial volumes of unreduced manganese, which are discarded on slag heaps. These slags are found as an environmental risk but are also probable sources of manganese if an appropriate method of retrieval could be found. Preferably, the slag could be remitted to the furnaces, but this may build-up of problems unlikely zinc limit and alkali metals and the total of recycling possible. For the steel industries Ferromanganese is an important alloying element. Manganese slag with the appearance of a rock is usually attained from the manganese ore during the mining process. Ferromanganese slags contain appreciable percentages of manganese, mainly in the term of silicate phases.

III. LITERATURE REVIEW

G.D. Ransinchung R.N., Praveen Kumar (2014) discussed about new design of W.M.M. In proposed design they replaced aggregate by moorum partially or completely. In this research they concluded that mixture of moorum and 3% OPC gives more C.B.R value than conventional W.M.M mix, permeability also retained which results into maximum cost savings. From cost comparisons it is noticed that significant savings on admixing as compared to the conventional W.M.M mix. **[1]**

O. Yazoghli-Marzouk, N. Vulcano-greullet (2014) presented the chemical interpretation of by- product (Foundry sand and natural sand), the articulation of a sub grade material evaluated by conducting experiments on site and monitoring. The result from the tests shows that the foundry sand which is treated by 5.5% hydraulic binder, shows satisfactory performances in terms of mechanical properties and don't shows environmental impacts. This investigation further validates that in the construction of various road layers the foundry sand can be utilized. **[2]**

Mr. Sagar B. Patil and Prof. Dhananjay S. Patil (2013) discussed about industrial waste material. Sand is used in the foundry industry for making molds for casting. This is recycled sand. Due to repeated use of sand its characteristics get reduced further this sand is unsuitable for manufacturing process. This sand is further dumped in land fill as a waste material. **[3]**

Robin L. Schroeder (2014) encapsulates present research on the waste materials that can be employed as alternative for traditional materials. Its emphases on new and advanced highway industry uses for waste materials and by-products, rather than on more commonly followed practices. **[4]**

D. S. V. Prasad and G. V. R. Prasad Raju (2009) discussed the application of waste tyre rubber as a reinforcing material on expansive soil sub-grade and in flexible pavements. In which gravel/flash used as sub-base course with waste tyre rubber. The lab test results of C.B.R and direct shear, shows that the gravel sub-base gives better functioning with respect to flash sub-base with varying % of waste tyre rubber. Cyclic load tests were carried out in the lab. For this test circular metal plate placed on the model flexible pavements. **[5]**

Siddique and Noumowe (2016) represented an indication of some of the research issued on the utilization of spent-foundry-sand in controlled low-strength materials and concrete. In the associated study, effects of spent-foundry-sand on controlled low-strength materials characteristics unlike plastic properties, namely permeability and leachate analysis, concrete properties such as splitting, CS, shrinkage, freeze-thaw resistance, modulus of elasticity and tensile strength are presented. **[6]**

Sofi Aanesah, Ar. Sukhmanjit (2017) This paper indicates the increase of the OMC-optimum moisture content contributes to the increase of the stabilized soils capability. These mixes were noticed to show a higher air voids ratio than required for normal mixes. In order to satisfy the design criteria higher bitumen content is required and to get usual trends. **[7]**

C.N.V. Satyanarayana Reddy (2013) discussed about addition of shredded tyre in flexible pavement. As per their conclusion mixture of soil-tyre chips can be used for Highway and Railway embankment construction. This mix increases sub-grade quality. Similarly, addition of tyre chips 2% by weight to aggregate helps to improve toughness and reduce wear and tear. **[8]**

Kamyar C. Mahboub, and Phillip R. Massie (2016) discussed use of scrap tire chips in an asphaltic membrane. The research project was designed with two objectives in mind. First to investigate the effectiveness of an asphaltic membrane on top of a subgrade for maintaining moisture equilibrium in subgrade, and second, to study the potential use of scrap tire chips in asphaltic membranes. The effectiveness of the membrane as a moisture barrier needs to be evaluated over a long period of time. However, the method proved to be a cost-effective way for recycling waste tires in pavements. It is hoped that this study will contribute to various efforts in the area of cost effective and sound utilization of waste materials in construction. **[9]**

W. Chebbi, O. Yazoghli-Marzouk, M. Dauvergne, L. Lumiere, A. Jullien (2016) This paper presents a case study of the environmental assessment of EAF-S (electric arc furnace slag) landfilling or recycling using life cycle assessment (LCA) in different "end of life" scenarios. Usually, the phases of life cycle corresponding to stockpiling and use are in general considered to have no impact counted in LCAs. Thus, in this study we undertake the evaluation of stockpiling and use phases impacts of a waste (EAF-S)

considering that the release of chemicals from the waste occurs during these phases and could be evaluated by EP and TP indicators. **[10]**

IV. RESULTS AND DISCUSSION

The literature review deliberates the various approaches towards studying and improving the basic properties of the Wet Mix Macadam and the various industrial wastes products used as a substitute alternative by using partial replacement to the natural aggregates used in the JMF of the Wet Mix Macadam. Also, the basic properties of the Wet Mix Macadam and the various industrial wastes used in the study i.e. Foundry sand, Tyre chips and the Ferromanganese slag are studied to their basic properties with respect to the desired properties requires to satisfy the basic need of the Wet Mix Macadam.

V. ACKNOWLEDGMENT

I would like to express an expression of gratitude towards my Professor Prof. A.N.Bhirud for their exceptional guidance, monitoring and continuous encouragement throughout this project. Their help, blessings and guidance given time to time shall carry me a long way. The project assisted me in learning proper Research and analysis, improve my research skills.

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