International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 01 | Jan 2021 www.irjet.net p-ISSN: 2395-0072

Durability of Potholes Filled with Waste Materials

Ahmad Zafar Merzakhill[1], Er. Jagdeep Singh[2]

[1]M.E. Research Scholar, Chandigarh University, Mohali 140413, Punjab, India
[2]Assistant Professor, Department of Civil Engineering, Chandigarh University, Mohali, 140413, Punjab, India

---

Abstract - *The aim of this review paper is to indicate how the utilization of waste materials is a big need of countries like India where the graph of plastic and other wastes is increasing day by day. So many authors have made various researches in the field of waste materials usages in road construction.*

As an example India generates annually 9.46 million tons of plastic waste, which 40 per cent remains uncollected and 43 per cent is used for packaging, most of them are single-use. Un-Plastic Collective (UPC).

Different locally available material can be used for patching of potholes such as: recycled waste plastic, crumb rubber, waste bricks, recycled aggregates from demolished buildings or roads, recycled waste glass and etc. Usage of waste materials like plastic, industrial waste, and demolished building wastes with locally available binders can help in reducing the expanses of construction techniques and materials as well, in addition it is proved to be an eco-friendly way of patching of potholes moreover it helps in waste reduction of materials from environment.

Key Words: **Potholes, Durability, Locally available materials, Eco-friendly mix, Utilization of waste materials from environment.**

1. INTRODUCTION

Potholes holes in the roadway that have different sizes and shapes. Potholes are caused by the expansion and contraction of ground water entered in to the ground beneath the road pavement.

Potholes are an annoyance to drivers and potentially a dangerous hazard on the roadways. Often on a road agency's agenda the repair of pothole in an asphalt pavement is considered low; however, the repair of potholes requires large portion of time and funds. A lot of road crews and labors are well familiar with proper methods and materials. A proper repair procedure application and selection of pothole patching materials can highly help with increasing the durability of pothole repairs, less driver frustrations, and decreases the road maintenance budgets.

A number of research work have been reported for the use of waste materials as pothole filling materials with bitumen and other standard binders that maybe are not available locally in the area. when the local people want to patch the potholes they need to use the local waste materials like waste plastic, demolished buildings and roads recycled wastes that are available, cost effective, easy to use and have sufficient strength.

1.1 Estimated potholes durability

First Category: Short-term durability (less than 1 year)

Second Category: Medium-term durability (from 1 to 3 years)

Third Category: Long-term durability (above 3 years)

1.2 Repair techniques:

1. Throw-and-go: This involves the placing of mixture into potholes followed by little or no compaction. While this is the most common and easy way of pothole patching, it is also the least effective.

2. Throw-and-roll: This method consists of placing the patching material into the pothole and then compacting the patch using truck tires. The crown of compacted patch must be between 3mm and 6mm.

3. Semi-permanent: This method consists of removing the water and debris from the pothole. The mixture is placed into the pothole after the edges of the pothole are squared-up. After that the compacting of the mixture is done.

4. Spray injection: This method consists of blowing water and debris from the pothole. With a tack coat of binder, then the sides and bottom of the pothole are sprayed. After that, premixed aggregate with heated asphalt emulsion is sprayed into the pothole, and finally cover the pothole patched area with a layer of aggregate. In this method compacting is not necessary.

5. Edge seal: Like throw-and-roll, this method consists of placing the mixture in the pothole and compacting it using truck tires. Once the patch has dried, a ribbon of asphaltic tack material is placed on the patch edge and a layer of sand is placed on the tack material.

2. Scope of work

As recently the production of waste materials is growing annually in countries like India, there is a big need of utilizing waste materials and Recycle them in construction fields, which we can notice the potholes patching can be a good option in this case. Asphaltic roads in suburbs and local areas need maintenance continuously in case of cracks and potholes that is why Patching potholes with waste materials would be an economic and cost effective way in compare with other standard mixes which are commonly used. Filling and patching potholes with waste materials can be easy to perform and would require less labor and machinery, moreover if such patching is performed with a standard locally available materials combination and techniques they would have much longer durability and life span in comparison with manually old fashioned methods and materials which are commonly used by local people.

3. Literature Review

(Vasudevan, Velkennedy, Ramalinga Sekar, Sundarakannan 2010) they have shown that Stone coated aggregate was first coated with plastic generated from wastes like carry bags, films and foams and the plastic waste coated aggregate (PCA) was used as raw material for flexible pavements. PCA is then mixed with 60/70 or 80/100 bitumen. PCA+ bitumen mix showed better binding property, less wetting property, much less voids, higher marshal stability value.by this process a road of 1km length and 3.75m width can consume 100,000 carry bags and the road strength is increased 100% and there is no formation of potholes. [1]

(Rishi Singh Chhabra, Supriya Marik 2014) this review paper states that, different types of originate materials and construction technologies have been invented to show their suitability for design, construction and maintenance of potholes. That rubbers and Plastics can be one of them. Also considering the environmental approach, due to excessive use of polythene in day to day business, the pollution to the environment is enormous. The use of plastics such as carry bags, cups, etc. is constantly increases day by day. Since the polythene is not biodegradable, the need of the current hour is to use the waste polythene in some beneficial purposes. The use of these materials as a road construction proves eco-friendly, economical and use of plastic gives strength in the sub-base course of the pavement. [2]

(Qiao Dong, Baoshan Huang, and Xiaoyang Jia 2014) They have done an evaluation on cost effectiveness of the two patching techniques with different amount of combination of materials, this evaluation was done during a 14-month survey to investigate potholes patched on roads in different weather and traffic condition and was rated according to its overall distress conditions. With the field patches rated as 0, the service time was selected as the main performance index. Multiple liner regression was used to analyze the influence of patching methods, geometric features, materials, traffic factors and climatic conditions on the performance of patches. This review showed that around 70% of throw and roll patched served less than 14 months. For throw and roll patches performance of cold bag B was the best, followed by HMA, cold bag A and cold bag B respectively. Labor made up the majority of patching costs, as 50% to 60% of the total cost. But the cost of semi-permanent patches was much higher than throw and roll method because of the increase in equipment and labor. [3]

(Brajesh Mishra, Ravi Shanker Mishra 2015) They have shown that a review of various Industrial wastes for use in the construction of highway has been discussed in this paper. The waste materials are fly ash, blast furnace slag, cement kiln dust phosphogypsum, waste plastic bags, foundry sand, colliery sand and processed municipal solid waste (MSW) which are the industrial wastes posturing problems in the disposal and being deposited in the vicinity of industries in India. [4]

(Sunil J. Kulkarni 2015) Minimization of waste material is important aspect of the modern growth and development initiatives. Plastic is used in various domestic and industrial applications. Use of plastic bags and bottles is very common. The disposal of plastic waste is major problem due to non-biodegradable nature of plastic. The plastic can be used as feedstock for ethanol like products. It can be used for road construction and other construction related activities. The current review summarizes the research on use of waste plastic. [5]

(U.K.Guru Vittal & Dr I.K.Pateria 2016) In India Several thousand kilometres of roads are planned to be constructed under NHDP and PMGSY. This requires huge quantities of road construction materials. The most difficult challenge for development of road network is to execute projects in harmony with the concept of sustainable development, minimising adverse impact on the environment. Hence, use of locally available/ marginal materials should be accorded its rightful place for construction of low traffic volume rural road. Considerable savings in construction cost and slowing down of environmental degradation can be achieved by adopting use of marginal materials. [6]

(D.D. Adegoke,T. O. Ogundairo, D.O Olukanni, O.M. Olofinnade 2019) they have studied that The conventional construction materials such as sand, gravel, and limestone have been in use for a long time and still are in use till date. These conventional construction materials if continuously used, will have negative environmental impacts and gradually deplete thereby limiting our natural resources as well as affecting the level of productivity in the construction industries. Therefore, the use waste for materials such as slag, waste tires, demolition wastes, plastics wastes, mill tailings, shingles, geopolymers and glass as reasonable alternatives is essential due to the various areas in which they have been successfully utilized. Despite the challenges attached to the use of these materials, with improvement in technology, sustainability is ensured. [7]

(Zifeng Zhao, Feipeng Xiao, Serji Amirkhanian 2020) This review article summarizes recent applications of SWMs in pavement engineering between 2014 and 2019. Among various waste materials, this article focuses on six popular SWMs, namely RCAs, RAP, FA, BA, waste rubber and waste plastics. The objectives of this review article are to provide an insight into the field of solid waste recycling and add values to the application of SWMs as a reference for future studies. Besides introducing basic engineering properties of the structure after incorporating each SWM and novel researches, this article provide comparisons, concerns and future study alternative as regard to production methods, properties, novel researches, environmental benefits, and economic benefits after employing SWMs. [8]

(Rutticka Kedare 2020) In the paper researcher worked to make bricks from waste plastic and sand. This brick is resistant to oil, water, salts and acids. It is more durable as compared to other bricks and can withstand temperature up to 180 degrees Celsius. Researchers found that it is effective way of recycling waste plastic bags in the near future. Further the same material can be used effectively filling potholes on Indian roads. The bricks were subjected to various tests like temperature variation, resistance to acids, fire and saline water, compressive strength and hardness strength and determined superior performance to the material presently used on roads. [9]

(Johnson Kwabena Appiah, Victor Nana Berko-Boateng, Trinity Ama Tagbor 2016) The researchers in this paper forms part of research to solve two main problems in Ghana: firstly, the management of municipal solid waste (MSW), particularly with regards to used plastics which have overwhelmed major cities and towns; secondly, the formation of potholes onroads due to excessive traffic and axle weight. This study examines the effect of blending waste thermoplastic polymers, namely High density polyethylene (HDPE) and Polypropylene (PP) in Conventional AC-20 graded bitumen, at various plastic compositions. The plastics were shredded and blended with the bitumen 'in-situ', with a shear mixer at a temperature range of 160ºC-170ºC. [10]

(Manoj Sharma, Dr. Ashutosh S. Trivedi, Rohit Sahu 2016) they have stated that the waste materials is always a problem for the environment, some waste may be disposed easily some cannot. Plastic is also a kind of material whose disposal is always a tedious job. The disposal of waste effected the environment drastically, for minimizing this effect several research in various field is going on to recycle plastic safely. One of its ways is to use the waste plastics in road construction. Plastic road is a need of an hour as they not only consume waste plastic in an eco-friendly way, but also helpful in increasing the quality of the road. In this review paper we will thoroughly study some of the methods and technique through which plastic is used in the road construction and how these technologies suit in various conditions. From the study of some of the methods in which waste products are used in so many ways in the road construction by which we can utilize the plastic waste, industrial waste, agricultural waste, in addition to this they can also improve various properties of roads specified by various authorities like Ministry of road transport and highways, Indian Road Congress, ASTM and many others. [11]

(Qiao Dong, Baoshan Huang, Sheng Zhao 2016) This paper describes an experimental investigation in which field survey and laboratory tests were conducted to evaluate the performance of asphalt patching mixtures designed for winter season pothole repairs. Researcher done Special laboratory procedures like adhesiveness, cohesion, moisture susceptibility and loaded wheel tests, were investigated and modified to evaluate the bonding, freeze –thaw resistance and rutting potentials of the patching materials. The impact of different factors, including freeze condition, traffic level, speed limit, patch size and depth, on patching performance was analyzed based on a statistical analysis of 6-month field survey. Effects of testing conditions were investigated for testing pothole patching materials with cohesion, freeze – thaw and loaded wheel tests. It was found that testing temperatures, laboratory sample compaction efforts as well as wheel loading in loaded wheel test significantly affected the testing results of pothole patching materials. Proper modifications were recommended to improve the effectiveness of the laboratory tests. [12]

4. Conclusions

1. In the bid to construct, renovate or rehabilitate, some level of demolition takes place and this generates a lot of waste whose disposal in the long run poses environmental concern. Construction and Demolition wastes are generated all-through the lifespan of a project. At the maintenance stage, generated waste is minimal except renovation processes are on – going. As a result of the volume of waste generated, three basic waste generation activities can be classified: (i) New buildings construction, (ii) Old buildings demolition, and (iii) civil and infrastructural works .According to [11], it was discovered that the bearing capacity, resilient International Conference on Engineering for Sustainable World Journal of Physics: Conference Series 1378 (2019) 022058 IOP Publishing doi:10.1088/1742-6596/1378/2/022058 5 modulus and resistance to permanent deformation increased with the introduction of recycled demolition waste. [42], discovered that leaching of the pavement underlays could be taken care of by using recycled demolition waste. Different types of demolition wastes were collected, worked on, and results howed that they met the criteria for quarry subbase materials. Quarry waste was incorporated as aggregate in asphalt without any noticeable polishing effect.
2. Locally available or marginal materials may not sometimes meet the requirements of gradation and plasticity. While well graded material can be

compacted to a better degree (hence better strength), minor deviations from the specified gradation cut-off limits may be overlooked, if the material has adequate strength as shown in CBR test. Plasticity properties influence drainage and strength characteristics of the material. If the material is being used at a location where damage due to water ingress is expected to be minimum, even material with higher liquid limit or plasticity index can perform well. Hence, a judicious decision about their usage should be taken on a case to case basis.

3. Whenever locally available materials do not meet the specification limits, it would always be advisable to use such material for a test track construction and monitor its performance for a period of minimum two years. Wide scale usage of such material can undertake if the field performance of such material is satisfactory.
4. Utilization of RAP, BA, waste rubber and waste plastics does not pose potential threat to the environment, nor to human health in most scenarios. On the contrary, when RCAs are used in base course, leaching of inorganic elements can pose threat to groundwater and human health. When FA is used to stabilize pavement, naturally occurring radionuclides (NORs) in FA have potential threat to groundwater and human health.
5. When trying to enhance the properties of waste plastics by one or more polymerization actions, future researchers should pay attention to the cost and toxicity of the polymers participated in the chemical reactions.
6. Around 70% of throw-and-roll patches served less than 14 months. Throw-and-roll patches installed in the winter season deteriorated very fast, mainly due to the severe freezing weather conditions and insufficient compaction and curing. Patches that survived in the first winter usually were well compacted and fully cured, and they tended to serve much longer even with increased freeze times in the second winter.
7. Labor made up the majority of patching costs, accounting for 50% to 60% of the total. The costs of semi-permanent patches were much higher than costs for the throw-and-roll patches because of increased equipment and labor costs. Material costs accounted for a small part of the total: 20% for cold mixes and 2%~5% for HMA and semi-permanent techniques. Thus, using expensive yet high-quality materials could greatly increase the cost-effectiveness.
8. The problem of plastic waste can be minimized by reuse of plastic. Waste plastic can be used for synthesis of products like ethanol. The use of plastic for road construction is widely investigated area. The strength of the roads constructed with plastic mixed bitumen was found to be more than that constructed with usual material. The conversion of plastic waste into fuel oil was also successfully carried out by few investigators. It can be concluded that use of waste plastic can minimize the disposal problem and add to economic aspects of fuel synthesis and various construction activities.
9. Environmental impact of using such materials in road works, especially from the point of heavy metal leaching and ground water contamination is also required to be carried out before field usage.

REFERENCES

[1] Vasudevan, Velkennedy, Ramalinga Sekar, Sundarakannan, "Utilization of waste polymers for flexible pavement and easy disposal of waste polymers," J. International Journal of pavement research and technology, ISSN 1997-1400, Vol.3 No.1, Jan 2010

[2] Rishi Singh Chhabra & Supriya Marik, "A Review Literature On the Use of Waste Plastics and Waste Rubber Tires in Pavement", J. International Journal of Core Engineering and Management iJCEM, ISSN 2348-9510, Vol.1, 2014

[3] Qiao Dong, Baoshan Huang, and Xiaoyang Jia "Long-Term Cost-Effectiveness of Asphalt Pavement Pothole Patching Methods" Transportation Research Record: Journal of the Transportation Research Board, No. 2431, 2014

[4] Brajesh Mishra, Ravi Shanker Mishra, "A Study on Use of Industrial Wastes in Rural Road Construction", J. International journal of innovative research in science, engineering and technology, ISSN 2319-8753, Vol.4, Issue 11, Nov 2015

[5] Sunil J. Kulkarni, "A Review on Studies and Research on Use of Plastic Waste", J. International journal of research and review, ISSN 2349-9788, Vol.2, Issue 11, Nov 2015

[6] U.K.Guru Vittal & Dr I.K, "Using locally available materials in road construction-problems & possibilities", Chief scientist & Head, Geotechnical engineering division, CSIR – Central road research institute, New Delhi – 110025

[7] D.D. Adegoke,T. O. Ogundairo, D.O Olukanni, O.M. Olofinnade, "Application of Recycled Waste Materials for Highway Construction, Prospect and Challenges", J. International conference on engineering for sustainable world, Journal of physics: Conference series, Conf. ser. 1378 022058, 2019

[8] Zifeng Zhao, Feipeng Xiao, Serji Amirkhanian, "Recent applications of waste solid materials in pavement engineering", J. International journal of Elsevier, ISSN 0956-053X, 2020

[9] Rutticka Kedare, "Physical Characterization of Waste-Plastic Brick and Development of material for pothole filling", J. International Journal of Scientific Development and Research (IJSDR), Vol. 5, 2455-2631, 2020

[10] Johnson Kwabena Appiah, Victor Nana Berko-Boateng, Trinity Ama Tagbor, "use of waste plastic materials for road construction in ghana" J international journal of Elsevier, Vol. 7, Nov 2016

[11] Manoj Sharma, Dr. Ashutosh S. Trivedi, Rohit Sahu, "A review on various methods of road construction using waste materials" J International journal of civil engineering research, ISSN 2278-3652, Vol.7, No.2 2016
[12] Qiao Dong, Baoshan Huang, Sheng Zhao, "Field and laboratory evaluation of winter season pavement pothole patching materials" J International Journal of Pavement Engineering, Vol. 15, No. 4, 279–289, 10 June 2013
[13] Jai Bhagwan & U.K.Guru Vittal, "use of marginal materials for rural road construction - some recent initiatives", Indian geotechnical conference 2014, organised by Indian geotechnical society, Kakinada, 2014
[14] U K Guru Vittal, Pankaj Gupta & N K Goyal, "using locally available materials for rural road construction", conference on sustainable asphalt pavements for developing countries (CONSAP), 11-12 March, 2016, SIR-CRRI, New Delhi
[15] Indian Roads Congress Special Publication 72, "Guidelines for design of flexible pavements for low volume roads", 2015
[16] Indian Roads Congress Special Publication 77, "Manual for design and maintenance of gravel roads", 2008 NRRDA, Ministry of Rural Development, Government of India, "Quality Assurance Handbook for Rural Roads", 2007
[17] Abdelfattah, H. F., Al-Shamsi, K., & Al-Jabri, 2018, "Evaluation of rutting potential for asphalt concrete mixes containing copper slag", J International Journal of Pavement Engineering, 19(7), 630-640, 2018
[18] Ahmari, S., Chen, R., & Zhang, L. 2012, "Utilization of mine tailings as road base Material", In GeoCongress 2012: State of the Art and Practice in Geotechnical Engineering, pp. 3654-3661, 2012
[19] Ameri, M., Hesami, S., & Goli, H, "Laboratory evaluation of warm mix asphalt mixtures containing electric arc furnace (EAF) steel slag", Construction and Building materials, 49, 611-617, 2013
[20] Arulrajah, A., Mohammadinia, A., Horpibulsuk, S., & Samingthong, W, "Influence of class F fly ash and curing temperature on strength development of fly ashrecycled concrete aggregate blends", Construction and Building Materials, 127, 743750, 2016

BIOGRAPHIES

Currently perusing mastering in Transportation Engineering (C.E) in Chandigarh University of Punjab, Mohali. Completed bachelors in Civil Engineering (C.E) from Takhar University of Afghanistan

Er. Jagdeep Singh Gahir, is currently working as Assistant Professor in Chandigarh University, Mohali, Punjab completed his graduation in Civil Engineering from Guru Nanak Dev Engineering College, Ludhiana. He also completed his M- Tech in Soil and foundation engineering in 2016. His area of research is Improvement in bearing capacity of Soil by micro piles or pin piles, Soil Stabilization. Along with teaching and research he filed 6 patents. He also developed methods of laboratory testing of suitability of micro piles for existing foundations.