Proceedings of the 10th World Congress on New Technologies (NewTech'24)
Barcelona, Spain - August 25-27, 2024
Paper No. ICCEIA 167
DOI: 10.11159/icceia24.167

Mask Residues In Asphalt Mixtures For Roads

Ana Ortiz-Viñán[1], Juan García[2], Juan Guanín-Vásquez[3]
[1] Department of Civil Engineering/Universidad Técnica Particular de Loja
San Cayetano, Loja, Ecuador
aportiz1@utpl.edu.ec; jfgarcia18@utpl.edu.ec
San Sebastian, Loja, Ecuador
jcguanin@utpl.edu.ec

Extended Abstract

The COVID-19 pandemic led to a significant increase in waste production, like the facial masks [1]. According to the World Health Organization (WHO), the global monthly demand for masks to combat the effects of COVID-19 was projected to be 89 million [2] [3]. The thermoplastic polymer components of these waste materials have degradation characteristics that extend over hundreds of years [4]. Waste treatment processes include incineration, landfill degradation, mechanical recycling, and chemical recycling [5].

In Ecuador, approximately 20% of waste production is adequately disposed of, while the 80% ends up in open-air landfills, dumps, rivers, or incinerators [6]. Researchers have explored the behaviour of adding waste materials from facial masks, such as polypropylene, to asphalt [7]. The results indicate its applicability, making it an alternative for sustainable use and promoting environmentally friendly practices [8]. These findings inspired this research aimed at analyzing the physical and mechanical behaviour of hot-mix asphalt containing the adittion of percentages of polypropylene fiber at percentages of 0,25%, 0,50%, 0,75%, and 1% of the fine aggregate fraction derived from discarded of the facial masks.

The polypropylene fiber was obtained from recycled common-use facial masks. After washing and air-drying, the central layer was extracted, crushed, and liquefied in the laboratory in order to get the fine fibers measuring between 1 mm and 2 mm. Laboratory tests were conducted on the remaining components of the asphalt mixture, including fine, coarse aggregates and AC-20 asphalt. The results were used to design asphalt mixtures following ASTM D 1559 (Marshall Method). Both the base mixture without any additive and mixtures with added polypropylene fiber were considered, with 5,72% asphalt content.

The results, in accordance with ASTM D 6927, shown the parameters established in the Ecuadorian Road Design Standard NEVI-12 for asphalt mixtures applied to medium-traffic roads, corresponding to an equivalent single-axle load between 300,000 and 10,000,000 ESALs. Particularly, improvements were observed in stability and flow properties when adding polypropylene fibber at percentages below 0,5%.

Compared to the standards set by regulations, there was a 44% increase in both stability and flow of the mixture. Furthermore, the polypropylene fiber-enhanced sample exceeded the stability the base mix asphalt by 1,31%.This composition ensures durability and necessary performance under vehicular traffic conditions and varying climates. According to [9], the increased strength may be attributed to the relative crystallinity of polypropylene, providing high tensile strength, rigidity, and hardness.

This research is significant because, it proposes a sustainable waste management alternative, aligning with Sustainable Development Goal 12, which aims to ensure sustainable consumption and production practices. It can serve as a foundation for future studies in waste management and the construction of sustainable infrastructure.

References

[1] W. Vilca-Quispe, Á. A. Ramírez-Puraca, C. G. Medina-Sotelo, and E. Loa-Navarro, 'Biocontaminant Waste, Another Legacy of COVID-19', *Produccion y Limpia*, vol. 16, no. 2. Corporación Universitaria Lasallista, pp. 197–211, 2021. doi: 10.22507/pml.v16n2a10.

[2] F. O. Sanchez-Gutierrez, 'Retos pos pandemia en la gestión de residuos sólidos', *CienciAmérica*, vol. 10, no. 1, pp. 11–23, Jan. 2021, doi: 10.33210/ca.v10i1.354.

[3] ‘Redacción Médica’, : https://www.redaccionmedica. com/secciones/sanidad-hoy/ coronavirus-la-oms-pide-aumentarla-produccion-de-mascarillas-enun-40—2649.
[4] Z. Zhao, S. Wu, Q. Liu, J. Xie, Ch. Yang, F.Wang, P. Wan, ‘Recycling waste disposable medical masks in improving the performance of asphalt and asphalt mixtures’, *Constr Build Mater*, vol. 337, Jun. 2022, doi: 10.1016/j.conbuildmat.2022.127621.
[5] S. Dharmaraj, V. Ashokkumar, S. Hariharan, A. Manibharathi, P. Loke Show, C. Tung Chong, ‘The COVID-19 pandemic face mask waste: A blooming threat to the marine environment’, *Chemosphere*, vol. 272. Elsevier Ltd, Jun. 01, 2021. doi: 10.1016/j.chemosphere.2021.129601.
[6] M. Villalba Ferreira, G. Dijkstra, P. Scholten, and D. Sucozhañay, ‘The effectiveness of inter-municipal cooperation for integrated sustainable waste management: A case study in Ecuador’, *Waste Management*, vol. 150, pp. 208–217, Aug. 2022, doi: 10.1016/j.wasman.2022.07.008.
[7] C. Massarra, M. H. H. Rahat, G. Wang, and H. Sadek, ‘Evaluating the cost of collection, processing, and application of face masks in hot-mix asphalt (HMA) pavements’, *Heliyon*, vol. 8, no. 11, Nov. 2022, doi: 10.1016/j.heliyon.2022.e11239.
[8] J. Zhu, M. Saberian, J. Li, E. Yaghoubi, and M. T. Rahman, ‘Sustainable use of COVID-19 discarded face masks to improve the performance of stone mastic asphalt’, *Constr Build Mater*, vol. 398, Sep. 2023, doi: 10.1016/j.conbuildmat.2023.132524.
[9] S. Chávez- Romero, Sh. Aulestia-Viscarra, W. Cando, J. Bucheli, and L. Fernández, ‘Evaluación de las propiedades mecánicas de una mezcla asfáltica en caliente modificada por vía seca con tapas plásticas de polipropileno’, *Revista Tecnica De La Facultad De Ingenieria Universidad Del Zulia*, vol. 42, no. 3, pp. 126–134, Aug. 2019, doi: 10.22209/rt.v42n3a04.