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Incorporating Plastic Wastes into Pavement Materials

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INTRODUCTION & AIM

- The accumulation of plastic waste is a considerable environmental concern, with continually low global recycling rates and an increasing reliance on landfilling.
- Incorporating waste plastics into asphalt pavements is a sustainable solution to divert waste from landfills and enhance pavement performance.
- Peer-reviewed studies were examined, emphasizing polymer type, inclusion method (dry or wet process), particle size, and dosage, with performance metrics including rutting resistance, fatigue life, moisture susceptibility, and environmental effects.
- This study integrates information from prior experimental and field investigations to assess the technical and environmental feasibility of plastic-modified asphalt.

METHOD

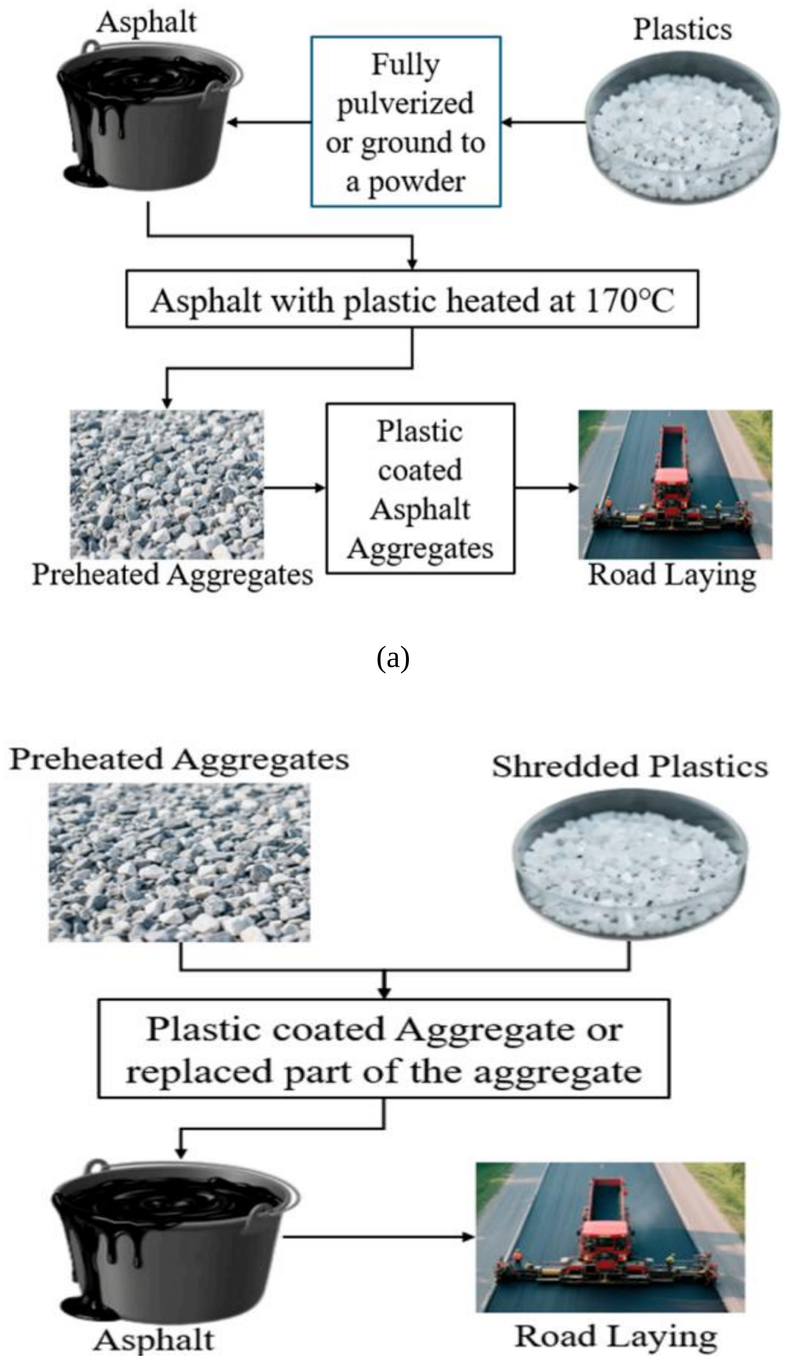

Fig 1. Plastic incorporation into asphalt pavement; a) Wet method and b) Dry method (Pan et al., 2025)

RESULTS & DISCUSSION

Table 1. The impact of different waste plastics on physical and mechanic properties of plastic modified bitumen.

Reference	Incorporation Method	Plastic Type	Plastic Dosage	Benefits	Limitations/ Drawbacks
Baghaee Moghaddam et al. (2015)	Dry method (Aggregate Replacement)	PET	1% by weight of aggregate	Cheaper, applicable in existing plans	Less uniform dispersion, diminished moisture resistance
Nuñez et al. (2014)	Wet (Binder Modifier)	LDPE	6% by weight of binder	Extended maintenance-free operating periods (MFOP); Up to 70% environmental impact reduction	Necessitates preprocessing and quality control infrastructure

Table 2. Performance of Plastic-Modified Bitumen Binder

Reference	Plastic Type	Incorporation Method	Key Performance Impacts
Zhang et al. (2023)	LDPE	Wet method	Softening point (57-68 ˚C), Penetration (up to 63%), Viscosity, improved rutting resistance
Alemu et al. (2023)	PET	Dry method	Marshall stability, stiffness, ITS

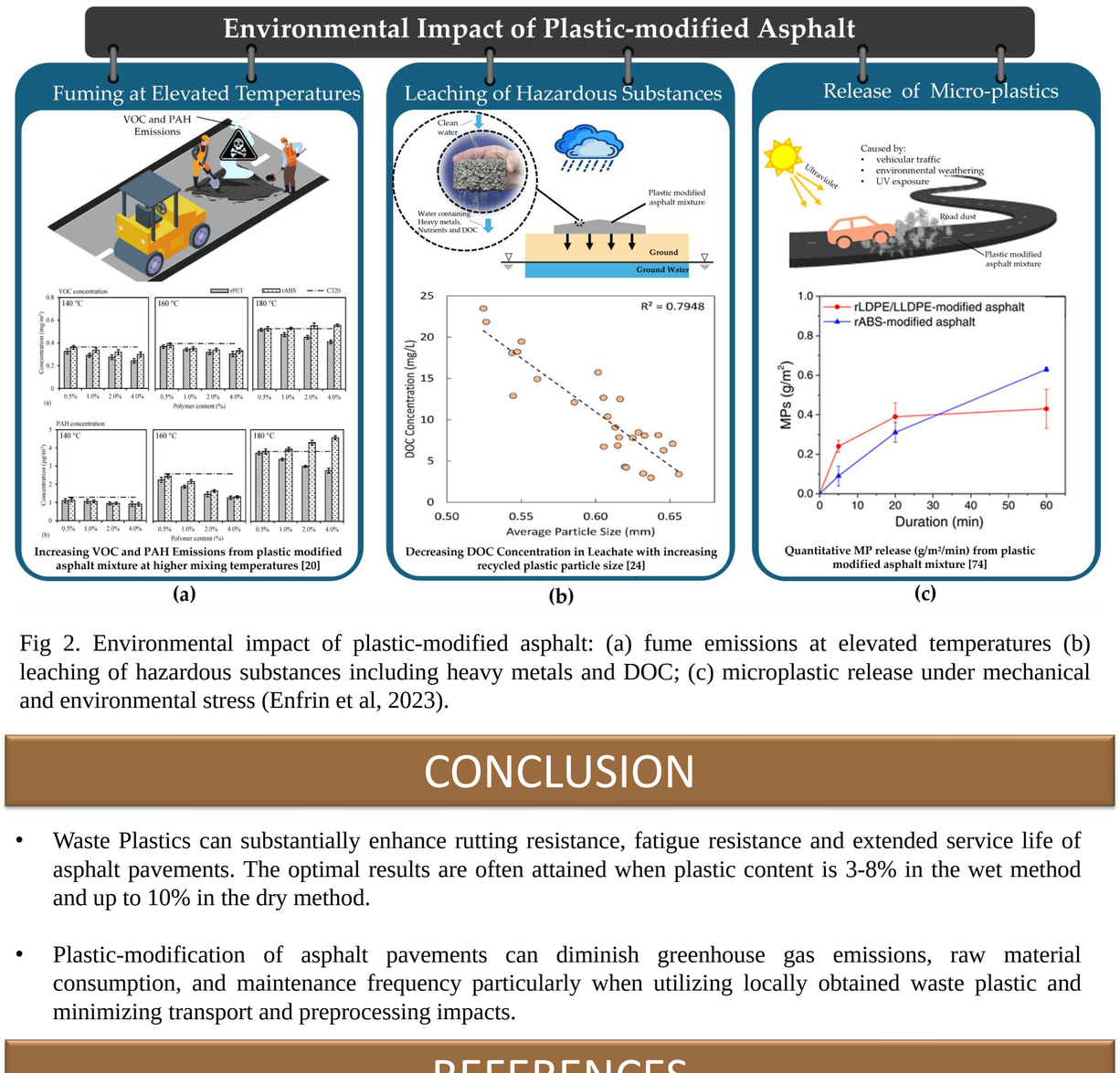

Fig 2. Environmental impact of plastic-modified asphalt: (a) fume emissions at elevated temperatures (b) leaching of hazardous substances including heavy metals and DOC; (c) microplastic release under mechanical and environmental stress (Enfrin et al, 2023).

CONCLUSION

- Waste Plastics can substantially enhance rutting resistance, fatigue resistance and extended service life of asphalt pavements. The optimal results are often attained when plastic content is 3-8% in the wet method and up to 10% in the dry method.
- Plastic-modification of asphalt pavements can diminish greenhouse gas emissions, raw material consumption, and maintenance frequency particularly when utilizing locally obtained waste plastic and minimizing transport and preprocessing impacts.

REFERENCES

Alemu, G.M.; Melese, D.T.; Mahdi, T.W.; Negesa, A.B. Combined performance of polyethylene terephthalate waste plastic polymer and crumb rubber in modifying properties of hot mix asphalt. Advances in Materials Science and Engineering 2023, 2023, 6320490.

Baghaee Moghaddam T, Soltani M, Karim MR, Shamshirband S, Petković D, Baaj H (2015) Estimation of the rutting performance of Polyethylene Terephthalate modified asphalt mixtures by adaptive neuro-fuzzy methodology, Constr Build Mater, vol. 96, pp. 550–555, Aug. https://doi.org/10.1016/j.conbuildmat.2015.08.043

Enfrin, M.; Boom, Y.J.; Giustozzi, F. Future recyclability of hot mix asphalt containing recycled plastics. Construction and Building Materials 2023, 368, 130396.

Nuñez JYM, Domingos MDI, Faxina AL (Oct. 2014) Susceptibility of low-density polyethylene and polyphosphoric acid-modified asphalt binders to rutting and fatigue cracking. Constr Build Mater 73:509–514. https://doi.org/10.1016/j.conbuildmat.2014.10.002.

Pan Ju, Li J, Shan B, Yao Y, et al. A comprehensive review of applications and environmental risks of waste plastics in asphalt pavements. Materials 2025;18: 3441. https://doi.org/10.3390/ma18153441.

Zhang, T.; Chen, Y.; Hu, K.; Zhang, W.; Chen, G. Investigating the compatibility mechanism of bitumen modified with photo-oxidative aging of polyethylene using molecular dynamics simulation. Journal of Materials in Civil Engineering 2023, 35, 04023424.