Supplementary Material

Assessing Benefits and Risks of Incorporating Plastic Waste in Construction Materials

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1. Supplementary Data

**Reviewed Literature List**

1. Ahmad F, Jamal A, Mazher KM, Umer W, Iqbal M. (2022). Performance Evaluation of Plastic Concrete Modified with E-Waste Plastic as a Partial Replacement of Coarse Aggregate. *Materials*, 15(1):175. doi: 10.3390/ma15010175
2. Alagbe, O. (2017). Architectural Solution to Economic and Environmental Challenges: The Generic Plastic Villa. *New Trends and Issues Proceedings on Humanities and Social Sciences*, 4(11). doi: 10.18844/prosoc.v4i11.2852
3. Aldagari, S., Kabir, S.F., Fini, E.H. (2021). Investigating aging properties of bitumen modified with polyethylene-terephthalate waste plastic. *Resources, Conservation and Recycling*, 173. doi: 10.1016/j.resconrec.2021.105687
4. Amankwa, M.O., Tetteh, E.K., Mohale, G.T., Dagba, G., and Opoku, P. (2021). The production of valuable products and fuel from plastic waste in Africa. *Discover Sustainability*, 2(1). doi: 10.1007/s43621-021-00040-z
5. Amena, S. (2021). Experimental study on the effect of plastic waste strips and waste brick powder on strength parameters of expansive soils. *Heliyon*, 7(11). doi: 10.1016/j.heliyon.2021.e08278
6. Anand, Hamdan, A. (2022). Impact of partial replacement of coarse aggregate with electronic plastic waste on compressive strength of concrete. *Materials Today: Proceedings*, 56. doi: 10.1016/j.matpr.2021.12.573
7. Armada, D., Llompart, M., Celeiro, M., Garcia-Castro, P., Ratola, N., Dagnac, T., et al. (2022). Global evaluation of the chemical hazard of recycled tire crumb rubber employed on worldwide synthetic turf football pitches. *Science of The Total Environment*, 152542, 812. doi: 10.1016/j.scitotenv.2021.152542
8. Arulrajah, A., Yaghoubi, E., Wong, Y.C., Horpibulsuk, S. (2017). Recycled plastic granules and demolition wastes as construction materials: Resilient moduli and strength characteristics. *Construction and Building Materials*, 147. doi: 10.1016/j.conbuildmat.2017.04.178
9. Badache, A., Benosman, A.S., Senhadji, Y., Mouli, M. (2018). Thermo-physical and mechanical characteristics of sand-based lightweight composite mortars with recycled high-density polyethylene (HDPE). *Construction and Building Materials*, 163. doi: 10.1016/j.conbuildmat.2017.12.069
10. Beran, R., Zárybnická, L., Machová, D., Večeřa, M., and Kalenda, P. (2021). Wood adhesives from waste-free recycling depolymerisation of flexible polyurethane foams. *Journal of Cleaner Production*, 305. doi: 10.1016/j.jclepro.2021.127142
11. Bolduc, S., Jung, K., Venkata, P., Ashokcline, M., Jayasinghe, R., Baillie, C., et al. (2018). Banana fiber/low-density polyethylene recycled composites for third world eco-friendly construction applications – Waste for life project Sri Lanka. *Journal of Reinforced Plastics and Composites*, 37(21). doi: 10.1177/0731684418791756
12. Breslin, V.T., Senturk, U., and Berndt, C.C. (1998). Long-term engineering properties of recycled plastic lumber used in pier construction. *Resources, Conservation and Recycling*, 23(4). doi: 10.1016/S0921-3449(98)00024-X
13. Bui, N.K., Satomi, T., and Takahashi, H. (2018). Recycling woven plastic sack waste and PET bottle waste as fiber in recycled aggregate concrete: An experimental study. *Waste Management*, 78. doi: 10.1016/j.wasman.2018.05.035
14. Chavan, J.V., Rane, A.R., Payghan, S.B., Durge, G.V., Dabhade, R.R., Pund, Dipali, S., et al. (2021). Utilization of Waste Plastic for Construction of Flexible Pavement. International Journal for Research in Applied Science and Engineering Technology, 9(VI). doi: 10.22214/ijraset.2021.35943
15. Conlon, K. (2022). Plastic roads: not all they’re paved up to be. *International Journal of Sustainable Development & World Ecology*, 29(1), 80-83. doi: 10.1080/13504509.2021.1915406
16. Connecticut Department of Environmental Protection. (2010). Artificial Turf Study: Leachate and Stormwater Characteristics. Accessed online: <https://portal.ct.gov/-/media/DEEP/artificialturf/DEPArtificialTurfReportpdf.pdf>
17. Costa, L.M.B., Silva, H.M.R.D., Peralta, J., and Oliveira, J.R.M. (2019). Using waste polymers as a reliable alternative for asphalt binder modification – Performance and morphological assessment. *Construction and Building Materials*, 198. doi: 10.1016/j.conbuildmat.2018.11.279
18. Dadzie, D.K., Kaliluthin, A. K., and Raj Kumar, D. (2020). Exploration of waste plastic bottles use in construction. *Civil Engineering Journal*, 6(11). doi: 10.28991/cej-2020-03091616
19. Estil, K. (2019). From waste to housing: Using plastic waste to build sustainable housing in Haiti. Florida Atlantic University, Boca Raton, Florida. Accessed online: [https://fau.digital.flvc.org/islandora/object/fau%3A42168/datastream/OBJ/view/FROM\_WASTE\_TO\_HOUSING\_\_USING\_PLASTIC\_WASTE\_TO\_BUILD\_SUSTAINABLE\_HOUSING\_IN\_HAITI.pdf](https://fau.digital.flvc.org/islandora/object/fau%252525252525253A42168/datastream/OBJ/view/FROM_WASTE_TO_HOUSING__USING_PLASTIC_WASTE_TO_BUILD_SUSTAINABLE_HOUSING_IN_HAITI.pdf)
20. Faraj, R.H., Hama Ali, H.F., Sherwani, A.F.H., Hassan, B.R., Karim, H. (2020). Use of recycled plastic in self-compacting concrete: A comprehensive review on fresh and mechanical properties. *Journal of Building Engineering*, 30. doi: 10.1016/j.jobe.2020.101283
21. Goli, V.S.N.S., Mohammad, A., and Singh, D.N. (2020). Application of Municipal Plastic Waste as a Manmade Neo-construction Material: Issues & Wayforward. *Resources, Conservation and Recycling*, 161. doi: 10.1016/j.resconrec.2020.105008
22. González Madariaga, F.J., and Macia, J.L. (2008). Mezclas de residuos de poliestireno expandido (EPS) conglomerados con yeso o escayola para su uso en la construcción. *Informes de la Construccion*, 60(509). doi: 10.3989/ic.2008.v60.i509.589
23. Graça, Cátia A.L., Rocha, F., Gomes, F.O., Rocha, M.R., Homem, V., Alves, A., et al. (2022). Presence of metals and metalloids in crumb rubber used as infill of worldwide synthetic turf pitches: Exposure and risk assessment. *Chemosphere*, 299, 134379. doi: 10.1016/j.chemosphere.2022.134379
24. Gulhane, S., and Gulhane, S. (2017). Analysis of Housing Structures Made From Recycled Plastic. *IRA-International Journal of Technology & Engineering*, 7(2 (S)), 45. doi: 10.21013/jte.icsesd201705
25. Hajikarimi, P., Sadat Hosseini, A., and Fini, E.H. (2022). Evaluation of the compatibility of waste plastics and bitumen using micromechanical modeling. *Construction and Building Materials*, 317. doi: 10.1016/j.conbuildmat.2021.126107
26. Halsband, C., Sørensen, L., Booth, A.M., and Herzke, D. (2020). Car Tire Crumb Rubber: Does Leaching Produce a Toxic Chemical Cocktail in Coastal Marine Systems? *Frontiers in Environmental Science*, 8. doi: 10.3389/fenvs.2020.00125
27. Haque, S., and Islam, S. (2021). Effectiveness of waste plastic bottles as construction material in Rohingya displacement camps. *Cleaner Engineering and Technology*, 3. doi: 10.1016/j.clet.2021.100110
28. Hita, P.R., Pérez-Gálvez, F., Morales-Conde, M.J., and Pedreño-Rojas, M.A. (2018). Reuse of plastic waste of mixed polypropylene as aggregate in mortars for the manufacture of pieces for restoring jack arch floors with timber beams. *Journal of Cleaner Production*, 198. doi: 10.1016/j.jclepro.2018.07.065
29. Huang, Y., Bird, R.N., and Heidrich, O. (2007). A review of the use of recycled solid waste materials in asphalt pavements. *Resources, Conservation and Recycling,* 51(1). doi: 10.1016/j.resconrec.2007.02.002
30. Jacob-Vaillancourt, C., and Sorelli, L. (2018). Characterization of concrete composites with recycled plastic aggregates from postconsumer material streams. *Construction and Building Materials*, 182. doi: 10.1016/j.conbuildmat.2018.06.083
31. Jalaluddin, M. (2017). Use of Plastic Waste in Civil Constructions and Innovative Decorative Material (Eco- Friendly). *IMOJ Civil Engineering*, 3(5). 10.15406/mojce.2017.03.00082
32. Jan, H., Aman, M.Y., Tawab, M., Ali, K., Ali, B. (2018). Performance Evaluation of Hot Mix Asphalt Concrete by Using Polymeric Waste Polyethylene. *EAI/Springer Innovations in Communication and Computing*. doi: 10.1007/978-3-319-70542-2\_7
33. Kaliyavaradhan, S.K., Prem, P.R., Ambily, P.S., Mo, K.H. (2022). Effective utilization of e-waste plastics and glasses in construction products - a review and future research directions. *Resources, Conservation and Recycling*, 176. doi: 10.1016/j.resconrec.2021.105936
34. Kamaruddin, M.A., Abdullah, M.M.A., Zawawi, M.H., and Zainol, M.R.R.A. (2017). Potential use of Plastic Waste as Construction Materials: Recent Progress and Future Prospect. *IOP Conference Series: Materials Science and Engineering*, 012011, 267. doi: 10.1088/1757-899X/267/1/012011
35. Kazemi, M., and Fini, E.H. (2022). State of the art in the application of functionalized waste polymers in the built environment. *Resources, Conservation and Recycling*, 177. doi: 10.1016/j.resconrec.2021.105967
36. Kazemi, M., Faisal Kabir, S., and Fini, E.H. (2021). State of the art in recycling waste thermoplastics and thermosets and their applications in construction. *Resources, Conservation and Recycling*, 174. doi: 10.1016/j.resconrec.2021.105776
37. Khan, I.M., Kabir, S., Alhussain, M.A., and Almansoor, F.F. (2016). Asphalt Design Using Recycled Plastic and Crumb-rubber Waste for Sustainable Pavement Construction. *Procedia Engineering*. doi: 10.1016/j.proeng.2016.04.196
38. Kucukvar, M., Egilmez, G., and Tatari, O. (2016). Life cycle assessment and optimization-based decision analysis of construction waste recycling for a LEED-certified university building. *Sustainability*, 8(1). doi: 10.3390/su8010089
39. Kumi-Larbi Jnr, A., Galpin, R., Manjula, S., Lenkiewicz, Z., and Cheeseman, C. (2022). Reuse of Waste Plastics in Developing Countries: Properties of Waste Plastic-Sand Composites. *Waste and Biomass Valorization*. 13, 3821–3834. doi: 10.1007/s12649-022-01708-x
40. Kusumawardani, D.M., Wong, Y.D., and Trinh, D.T. (2022). Value-Add Application of Plastic Waste in Porous Asphalt Mixture. *Lecture Notes in Civil Engineering*. doi: 10.1007/978-981-16-7160-9\_97
41. Lamba, P., Kaur, D.P., Raj, S., and Sorout, J. (2022). Recycling/reuse of plastic waste as construction material for sustainable development: a review. *Environmental Science and Pollution Research*, 29(57), 86156-86179. doi: 10.1007/s11356-021-16980-y
42. Lauria, M.Z., Naim, A., Plassmann, M., Fäldt, J., Sühring, R., and Benskin, J.P. (2022). Widespread Occurrence of Non-Extractable Fluorine in Artificial Turfs from Stockholm, Sweden. *Environmental Science & Technology Letters*, 9(8), 666-672. doi: 10.1021/acs.estlett.2c00260
43. Lazorenko, G., Kasprzhitskii, A., and Fini, E.H. (2022). Sustainable construction via novel geopolymer composites incorporating waste plastic of different sizes and shapes. *Construction and Building Materials*, 324. doi: 10.1016/j.conbuildmat.2022.126697
44. Leng, Z., Sreeram, A., Padhan, R.K., and Tan, Z. (2018). Value-added application of waste PET based additives in bituminous mixtures containing high percentage of reclaimed asphalt pavement (RAP). *Journal of Cleaner Production*, 196. doi: 10.1016/j.jclepro.2018.06.119
45. Levytska, O., Trus, I., Gomelya, M., and Alekseyenko, S. (2022). Technology of Utilization of Polypropylene Waste and Wastewater Sediments by Production of Building Blocks. *Ecological Engineering and Environmental Technology*, 23(2). doi: 10.12912/27197050/144995
46. Luhar, S., and Luhar, I. (2019). Potential application of E-wastes in construction industry: A review. *Construction and Building Materials*, 203. doi: 10.1016/j.conbuildmat.2019.01.080
47. Lysyannikov, A.V., Egorov, A.V., Lysyannikova, N.N., Shram, V.G., Kovaleva, M.A., Lynev, A.S., et al. (2019). Polymer materials from recycled plastic in road construction. *Journal of Physics: Conference Series*. doi: 10.1088/1742-6596/1399/4/044064
48. Madghe, P., Berad, H., Roy, A., Vaidya, N., Sakharwade, N., and Wankhade, R.L. (2022). Use of Waste Polymers in a Plastic Bricks as Sustainable Building and Construction Materials. *Lecture Notes in Civil Engineering*. doi: 10.1007/978-981-16-6557-8\_62
49. Mahdi, E.M., and Abdulfatah, M.E. (2018). Producing lightweight concrete from locally available plastic wastes. *International Journal of Civil Engineering and Technology*, 9(10). e-ISSN: 0976-6316
50. Meng, Y., Ling, T.C., and Mo, K.H. (2018). Recycling of wastes for value-added applications in concrete blocks: An overview. *Resources, Conservation and Recycling*, 138. doi: 10.1016/j.resconrec.2018.07.029
51. Milad, A., Ali, A.S.B., and Yusoff, N.I. (2020). A review of the utilisation of recycled waste material as an alternative modifier in asphalt mixtures. *Civil Engineering Journal*, 6. doi: 10.28991/cej-2020-SP(EMCE)-05
52. Mohammadinia, A., Wong, Y.C., Arulrajah, A., and Horpibulsuk, S. (2019). Strength evaluation of utilizing recycled plastic waste and recycled crushed glass in concrete footpaths. *Construction and Building Materials*, 197. doi: 10.1016/j.conbuildmat.2018.11.192
53. Mohan, H.T., Jayanarayanan, K., and Mini, K. M. (2022). A sustainable approach for the utilization of PPE biomedical waste in the construction sector. *Engineering Science and Technology, an International Journal*, 32. doi: 10.1016/j.jestch.2021.09.006
54. Murphy, M., and Warner, G.R. (2022). Health impacts of artificial turf: Toxicity studies, challenges, and future directions. *Environmental Pollution*, 310, 119841. doi: 10.1016/j.envpol.2022.119841
55. Naran, J.M., Gonzalez, R.E.G., del Rey Castillo, E., Toma, C.L., Almesfer, N., van Vreden, P., et al. (2022). Incorporating waste to develop environmentally-friendly concrete mixes. *Construction and Building Materials*, 314. doi: 10.1016/j.conbuildmat.2021.125599
56. Nyuk Khui, P.L., Rahman, R., Matin, M., and Bin Bakri, M.K. (2022). Recycled rubber waste plastic and its composites. *Recycled Plastic Biocomposites*. doi: 10.1016/B978-0-323-88653-6.00014-6
57. Oliveira, P.R., Kilchert, S., May, M., Panzera, T.H., Scarpa, F., and Hiermaier, S. (2022). Environmental assessment of discarded plastic caps as a honeycomb core: An eco-mechanical perspective. *Journal of Industrial Ecology*, 26(2). doi: 10.1111/jiec.13211
58. Parece, S., Rato, V., Resende, R., Pinto, P., and Stellacci, S. (2022). A Methodology to Qualitatively Select Upcycled Building Materials from Urban and Industrial Waste. *Sustainability*, 14(6). doi: 10.3390/su14063430
59. Pavilonis, B.T., Weisel, C.P., Buckley, B., and Lioy, P.J. (2014). Bioaccessibility and Risk of Exposure to Metals and SVOCs in Artificial Turf Field Fill Materials and Fibers. *Risk Analysis*, 34(1), 44-55. doi: 10.1111/risa.12081
60. Perera, S., Arulrajah, A., Wong, Y., Maghool, F., and Horpibulsuk, S. (2020). Evaluation of shear strength properties of unbound PET plastic in blends with demolition wastes. *Construction and Building Materials*, 262. doi: 10.1016/j.conbuildmat.2020.120545
61. Perera, S., Arulrajah, A., Wong, Y.C., Horpibulsuk, S., and Maghool, F. (2019). Utilizing recycled PET blends with demolition wastes as construction materials. *Construction and Building Materials*, 221. doi: 10.1016/j.conbuildmat.2019.06.047
62. Pradeep, L., Pragyan Dash, S., Jivan Pati, D., and Mary Boby, N. (2022). Determining the feasibility of using PET bottles as construction material in urban context. *Materials Today: Proceedings*, 60. doi: 10.1016/j.matpr.2022.01.254
63. Raad, D., and Assaad, J.J. Structural properties of fiber-reinforced concrete containing thermosetting polymer plastic wastes. *Journal of Sustainable Cement-Based Materials*, 11(2). doi: 10.1080/21650373.2021.1899998
64. Rahman, S.S., Siddiqua, S., and Cherian, C. (2022). Sustainable applications of textile waste fiber in the construction and geotechnical industries: A retrospect. *Cleaner Engineering and Technology*, 6. doi: 10.1016/j.clet.2022.100420
65. Ribeiro, M.C.S., Meira-Castro, A.C., Silva, F.G., Santos, J., Meixedo, J.P., and Fiúza, A., et al. (2015). Re-use assessment of thermoset composite wastes as aggregate and filler replacement for concrete-polymer composite materials: A case study regarding GFRP pultrusion wastes. *Resources, Conservation and Recycling*, 104. doi: 10.1016/j.resconrec.2013.10.001
66. Rigotti, D., and Dorigato, A. (2022). Novel uses of recycled rubber in civil applications. *Advanced Industrial and Engineering Polymer Research*, 5(4), 214-233. doi: 10.1016/j.aiepr.2022.08.005
67. Saberian, M., Li, J., Kilmartin-Lynch, S., and Boroujeni, M. (2021). Repurposing of COVID-19 single-use face masks for pavements base/subbase. *Science of the Total Environment*, 769. doi: 10.1016/j.scitotenv.2021.145527
68. Sabrada, V. (2017). Use of Polymer Modified Bitumen in Road Construction. *International Research Journal of Engineering and Technology*, 799-801, 4(12). e-ISSN: 2395-0056
69. Salehi, S., Arashpour, M., Kodikara, J., and Guppy, R. (2022). Comparative life cycle assessment of reprocessed plastics and commercial polymer modified asphalts. *Journal of Cleaner Production*, 337. doi: 10.1016/j.jclepro.2022.130464
70. Salehi, S., Arashpour, M., Kodikara, J., and Guppy, R. (2021). Sustainable pavement construction: A systematic literature review of environmental and economic analysis of recycled materials. *Journal of Cleaner Production*, 313. doi: 10.1016/j.jclepro.2021.127936
71. Sandanayake, M., Bouras, Y., and Vrcelj, Z. A feasibility study of using coffee cup waste as a building material - Life cycle assessment and multi-objective optimisation. *Journal of Cleaner Production*, 339. doi: 10.1016/j.jclepro.2022.130498
72. Santos, J., Pizzol, M., and Azarijafari, H. (2022). Life cycle assessment (LCA) of using recycled plastic waste in road pavements: Theoretical modeling. *Plastic Waste for Sustainable Asphalt Roads*. doi: 10.1016/B978-0-323-85789-5.00014-9
73. Santos, J., Pham, A., Stasinopoulos, P., Giustozzi, F. (2021). Recycling waste plastics in roads: A life-cycle assessment study using primary data. *Science of the Total Environment*, 751. doi: 10.1016/j.scitotenv.2020.141842
74. Selvaranjan, K., Navaratnam, S., Rajeev, P., and Ravintherakumaran, N. (2021). Environmental challenges induced by extensive use of face masks during COVID-19: A review and potential solutions. *Environmental Challenges*, 3. doi: ​​10.1016/j.envc.2021.100039
75. Senthil Kumar, K., and Baskar, K. (2015). Recycling of E-plastic waste as a construction material in developing countries. *Journal of Material Cycles and Waste Management*, 17(4). doi: 10.1007/s10163-014-0303-5
76. Senthil Kumar, K., and Baskar, K. (2018). Effect of Temperature and Thermal Shock on Concrete Containing Hazardous Electronic Waste. *Journal of Hazardous, Toxic, and Radioactive Waste*, 22(2). doi: 10.1061/(asce)hz.2153-5515.0000387
77. Shahidan, S., Ranle, N.A., Zuki, S.S., Khalid, F.S., Ridzuan, A.R.M., and Nazri, F.M. (2018). Concrete incorporated with optimum percentages of recycled polyethylene terephthalate (PET) bottle fiber. *International Journal of Integrated Engineering*, 10(1). doi: 10.30880/ijie.2018.10.01.001
78. Siddique, R., Khatib, J., and Kaur, I. (2008). Use of recycled plastic in concrete: A review. *Waste Management*, 28(10). doi: 10.1016/j.wasman.2007.09.011
79. Silva, J.A.A., Rodrigues, J.K.G., de Carvalho, M.W., Lucena, L.C.F.L., Cavalcante, E.H. (2018). Mechanical performance of asphalt mixtures using polymer-micronized PET-modified binder. *Road Materials and Pavement Design*, 19(4). doi: 10.1080/14680629.2017.1283353
80. Simcox, N.J., Bracker, A., Ginsberg, G., Toal, B., Golembiewski, B., Kurland, T., et al. (2011). Bio-accessibility and Risk of Exposure to Metals and SVOCs in Artificial Turf Field Fill Materials and Fibers. *Journal of Toxicology and Environmental Health, Part A*, 74(17), 1133-1149. doi: 10.1080/15287394.2011.586941
81. Soni, A., Das, P.K., Sarma, M.J. (2022). Application of MOORA Method for Parametric Optimization of Manufacturing Process of Floor Tiles Using Waste Plastics. *Process Integration and Optimization for Sustainability*, 6(1). doi: 10.1007/s41660-021-00205-3
82. Taiwo, O.O., and Abas, N.F. (2021). Plastic Tiles from Recycled Pet Bottles Wastes with Improved Strength and Reduced Flammability. *Civil Engineering and Architecture*, 9(5), 1347-1355. doi: 10.13189/cea.2021.090508
83. Tejaswini, M.S.S.R., Pathak, P., Ramkrishna, S., and Ganesh, P.S. (2022). A comprehensive review on integrative approach for sustainable management of plastic waste and its associated externalities. *Science of the Total Environment*, 825. doi: 10.1016/j.scitotenv.2022.153973
84. Tempa, K., Chettri, N., Thapa, G., Phurba, Gyeltshen, C., and Norbu, D., et al. (2022). An experimental study and sustainability assessment of plastic waste as a binding material for producing economical cement-less paver blocks. *Engineering Science and Technology, an International Journal*, 26. doi: 10.1016/j.jestch.2021.05.012
85. Thorneycroft, J., Orr, J., Savoikar, P., and Ball, R.J. (2018). Performance of structural concrete with recycled plastic waste as a partial replacement for sand. *Construction and Building Materials*, 161. doi: 10.1016/j.conbuildmat.2017.11.127
86. Turku, I., Kärki, T., and Puurtinen, A. (2018). Flammability of wood plastic composites prepared from plastic waste. *Fire and Materials*, 42(2), 198-201. doi: 10.1002/fam.2480
87. Turku, I., Keskisaari, A., Kärki, T., Puurtinen, A., and Marttila, P. (2017). Characterization of wood plastic composites manufactured from recycled plastic blends. *Composite Structures*, 161. doi: 10.1016/j.compstruct.2016.11.073
88. Usman, A., Sutanto, M.H., and Napiah, M. (2018). Effect of Recycled Plastic in Mortar and Concrete and the Application of Gamma Irradiation-A Review. *E3S Web of Conferences*. doi: 10.1051/e3sconf/20186505027
89. Vaccaro, P., Galvín, A.P., Ayuso, J., Lozano-Lunar, A., and López-Uceda, A. (2021). Pollutant potential of reinforced concrete made with recycled plastic fibres from food packaging waste. *Applied Sciences*, 11(17). doi: 10.3390/app11178102
90. Vasudevan, R., Ramalinga Chandra Sekar, A., Sundarakannan, B., and Velkennedy, R. (2012). A technique to dispose waste plastics in an ecofriendly way – Application in construction of flexible pavements. *Construction and Building Materials*, 28(1), 311-320. doi: 10.1016/j.conbuildmat.2011.08.031
91. Vercher, J., Diaz, A., Soriano, M., and Lerma, C. (2019). Assessment of Color Degradation of Wood Plastic Composites in Outdoor Applications. *Applied Mechanics and Materials*, 887. doi: 10.4028/www.scientific.net/amm.887.48
92. Vidales Barriguete, A., del Río Merino, M., Atanes Sánchez, E., Piña Ramírez, C., and Viñas Arrebola, C. (2018). Analysis of the feasibility of the use of CDW as a low-environmental-impact aggregate in conglomerates. *Construction and Building Materials*, 178. doi: 10.1016/j.conbuildmat.2018.05.011
93. Vila-Cortavitarte, M., Lastra-González, P., Calzada-Pérez, M.A., and Indacoechea-Vega, I. (2018). Analysis of the influence of using recycled polystyrene as a substitute for bitumen in the behaviour of asphalt concrete mixtures. *Journal of Cleaner Production*, 170. doi: 10.1016/j.jclepro.2017.09.232
94. Weis, P., Weis, J.S., Greenberg, A., and Nosker, T.J. (1992). Toxicity of construction materials in the marine environment: A comparison of chromated-copper-arsenate-treated wood and recycled plastic. *Archives of Environmental Contamination and Toxicology*, 22(1), 99-106. doi: ​​10.1007/BF00213307
95. Xu, X., Chen, G., Wu, Q., Leng, Z., Chen, X., and Zhai, Y., et al. (2022). Chemical upcycling of waste PET into sustainable asphalt pavement containing recycled concrete aggregates: Insight into moisture-induced damage. *Construction and Building Materials*, 360, 129632. doi: 10.1016/j.conbuildmat.2022.129632
96. Yilmaz, A. (2021). Mechanical and durability properties of cement mortar containing waste pet aggregate and natural zeolite. *Ceramics*, 65(1). doi: 10.13168/cs.2021.0001
97. Yin, S., Tuladhar, R., Shi, F., Combe, M., Collister, T., and Sivakugan, N. (2015). Use of macro plastic fibres in concrete: A review. *Construction and Building Materials*, 93, 180-188. doi: 10.1016/j.conbuildmat.2015.05.105
98. Yin, S., Tuladhar, R., Sheehan, M., Combe, M., and Collister, T. (2016). A life cycle assessment of recycled polypropylene fibre in concrete footpaths. *Journal of Cleaner Production*, 112, 2231-2242. doi: 10.1016/j.jclepro.2015.09.073
99. Zakaria, N.M. (2020). Characterisation of bitumen and asphalt mixture with recycled waste plastic (RWP) modified binder. PhD thesis, University of Nottingham. http://eprints.nottingham.ac.uk/61592/
100. Záleská, M., Pavlíková, M., Jankovský, O., Lojka, M., Pivák, A., and Pavlík, Z. (2018). Experimental analysis of MOC composite with a waste-expanded polypropylene-based aggregate. *Materials*, 11(6). doi: 10.3390/ma11060931

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