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Experimental Investigation on Replacement of Bitumen with PCB Powder (E-Waste)

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ABSTRACT

The main goal of this experiment is to replace certain percentage of pcb powder in Bitumen which is used in pavement construction. Due to increase in demand of raw materials there is depletion of raw materials nowadays which make depletion of resources for the future generation. It is an attempt to use waste products like E-Waste which harm the environment and difficult to decompose and reuse.

Keywords:Bitumen, PCB Powder, E-Waste.

INTRODUCTION

Electronic waste or e-waste refers to all items of electrical and electronic equipment (EEE) and its parts that have been discarded as waste without the intent of reuse. E-waste includes computers, entertainment electronics, mobile phones, and other electronic items that have been discarded.One of the major environmental perils of urbanization imposed upon society is the incerasein Electronic Waste or E-waste which is non degradable.At present the safe disposal of E-waste has become a major waste management problem in the world.The use of e-waste mixture in the pavement construction with bitumen ensures its safe, useful and environmental friendly disposal.Use of e-waste is expected to yield better and enhanced desirable charecteristics in the flexible pavement. Use of E-waste in the pavement is found to be economical.

METHODOLOGY

1. E-Waste collected from Marenahalli recyclers in the form of powder
2. E-Waste powder sieved in 150micron and 300 micron.
3. The physical properties like moisture content, density and surface area of E-Waste is evaluated.
4. To investigate chemical composition EDS is implemented.
5. To determine microscopic scale of the E-Waste powder SEM is evaluated.
6. Preparation of samples.
7. Mix design for Marshal Stability strength.
8. Experimental program (controlled specimen and varying percentage of mixes).
9. Results and comparisons.

Flow chart

Collection of materials

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Preliminary testing of materials

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Testing by adding certain percentage of pcb powder(E-waste)

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Conducting all the laboratory experiments

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Final result

LITERATURE REVIEW PAPERS

SL NO.	AUTHORS	JOURNAL	MATERIAL	INFERENCE
1	G. Ramesh Kumar, K.S. Santosh, S. Bharani.	Materials today: proceedings August – 2020.	E-Waste.	1. The optimum ratio of E-waste powder in Bitumen was found out to be 12% by weight of Bitumen. 2. In addition to the optimum value, 5%, 10%, and 15% of non-metallic chips are replaced to aggregate and it was added to the modified bitumen. 3. In the above value, a 10% addition of non-metallic chips shows better stability and binder capacity compared to other results.
2	Manjay Kumar Singh, PratikshaMalviya.	International Journal of Trend in Scientific Research and Development (IJTSRD)	E-Waste as partial replacement of aggregate	Marshal Stability values and flow value of bituminous mix are increased due to addition of E-Waste.
3	YateenLokesh, Rajesh Gopinath, Akansh Patel, Amit Kumar Mishra, Avinash D. And B. T. Kiran Kumar Sajjan	Journal "Scientific Israel-Technological Advantages" Vol.17, no 4, 2015	E-waste ceramics	The maximum replacement of E-waste ceramics in Bituminous Concrete Grade-1 Mix achieved was 10%, and this satisfied MORT&H 4th Revision Standards. This can amount to sustainable diversion of one tenth of E-wastes disposed recklessly into municipal landfills, and the cost estimation analysis indicated a saving of INR 8891 per km with the application of 10% ceramics and 5.5% bitumen.
4	Manjay Kumar Singh, PratikshaMalviya	International Journal of Trend in Scientific Research and Development (IJTSRD)	E-Waste	It has been observed when the E-WASTE is mixed with bitumen with varying % (4, 8, 10, and 12) properties of bitumen like penetration value, ductility, flash and fire point, specific gravity and softening point change. As discussed earlier in chapter 5 it is observed experimentally that the penetration, ductility decreased and softening point and specific gravity values are increased as the % of E-WASTE increases. While in the case of flash and fire point values first increases (with 4, 8 and 10%) and then decreases at 12% of E-WASTE. significant change in properties of DBM was observed as per follows.
5	S.Sabarai Mani, I.Seeni Mohamed, P.NatarajPrabu&M.Rajkumar	International Research Journal of Engineering Sciences	E-Waste and Fly ash	The bituminous concrete mixed have been found 10 to 15% of e-waste was found to be optimal. The use of e-waste in road construction will serve two purposes, It will reduce the cost, It will contributes towards efficient waste management. Fly as a mineral filler will increase the stability of the bituminous road
6	Vikram J. Patel1 , Hemraj R. Kumavat2 , Ganesh V. Tapkire3	International Journal of Innovative Research in Science, Engineering and Technology	Electronic Waste	The Test Conducted on Bitumen were held with precision and the results for 5%, 10% replacement with were successful. Bitumen with 10 % replacement can be used while paving of road. The test with 15% replacement were also conducted, but the results were not as per the standards hence, they were neglected from the report. If more research is done with 15% replacement, it is possible that, the test can be successful. E-Waste management is a new concept .If the Procedure in the report comes into existence, then the Environment issues with Electronic Waste can be resolved. If this Procedure is implemented in every city then the electronic waste production can be minimized.
7	RajatKajal, Rajesh Chauhan	International Journal of Advance Research, Ideas and Innovations in Technology	E-Waste and Fly ash	• The physical properties of coarse aggregates and bitumen are determined by standard tests which satisfy the MORT&H requirements. • With the 10% e-waste as a coarse aggregates and 7% of flyash as a filler replacement increase the

				stability at 5.5% optimum bitumen content as compare to nominal mix. • It is observed that there is decrease in the flow design mix as compare to nominal mix but the flow is under MORT&H requirements. • Also decrease in bulk density but it also under the MORT&H requirements.
8	NeedhidasanSanthanam , B. Ramesh, S. Gorab Agarwal	Materials Today: Proceedings	E-Waste Plastics	1) The test results have shown that the E-waste plastic powder can be used in pavements along with the conventional bitumen for better strength. 2) The test conducted on bitumen for 5%, 10% and 15% replacement with E-waste plastic powder shows better strength and therefore 10% replacement can be used for pavement of roads. 3) E-waste management is the new idea and the same procedure is followed environmental impacts can be minimised. 4) Fly ash and stone dust can also be considered for future studies for better strength.
9	Anjali Deshmukh, V. Anbukarasi, R. Bhuvaneswaran, E. Sivagnanam and S. TamizhVendan	International Journal of Science, Environment and Technology, Vol. 9, No 2, 2020, 173 – 179	E-Waste and Polymer	As seen from the above results it is concluded that at 5% optimum bitumen content in which 1% of bitumen is replaced by waste plastic and 15% of aggregate is replaced by e-waste shows the increase in the stability. E-waste increases the strength and plastic increases the flexibility and durability of the mix. Beyond 15% addition of e-waste, the stability drops gradually. The flow value increases up to 15% addition of e-waste and then drops. The density of the modified bituminous mix is minimum compared to conventional bituminous mix. This is due to the increase in content of the e-waste. From the experimental work, it is evident that the modified bituminous mix is much more superior to that of the conventional mix. It is clear that there is a difference in values of the mix when compared to conventional values. Hence, the modified bituminous mix can be used for practical applications thereby reducing the harmful effects of e-waste and plastic waste in the environment. There is further scope of work in this area as there can be more variations in the bitumen and waste content.
10	JaviyaDarshit, YogeshAlwani, Himanshu Gupta	International Journal of Advance Engineering and Research Development	E-Waste and Fly ash	1. The laboratory investigation proved that suitability of electronic waste and fly-ash in road construction with cost saving and shows better strength. 2. Different Percentage of aggregate was volumetrically replaced by different percentage of electronic waste and fly-ash in BC layer. 3. 7.5 % of aggregate was volumetrically replaced by electronic waste in DBM layer with 5.5% optimum binder content have good Marshall Stability. It is concluded that at 5.5% bitumen content and 10 % e-waste as replacement attained maximum strength. 4. When the e-waste percentage is increase beyond 7.5 %, Stability is decrease. 5. Marshall Stability value was increase about 25% by addition of fly-ash material with replacement of aggregate. 6. Fly-ash replacement with stone dust is about 4-12% but replacement of fly-ash with 4% shows the maximum stability.
11	G. Gaidajis, K. Angelakoglou and D. Aktsoglou	Engineering Science and Technology Review	E-Waste	Electronic equipment and therefore e-waste are everywhere in our society. They are characterized by a complex chemical composition and difficulty in quantifying their flows at a local and international level. The pollution caused by their irregular

				management substantially degraded the environment mostly in poorer countries, receiving them for recycling and recovery of their valuable metals. As for the consequences on ecosystems, human health and environmental restoration of areas burdened by certain polluters generated by e-waste (e.g. Li and Sb), there are no sufficiently documented scientific studies. Motivated by the minimization of environmental effects caused by the generated e-waste, many technological changes have been effectuated.
12	Surya Muthukumar, Bavithran.O.K.C, Nandhagopal.A.R, Snehasree.T	International Journal of Civil Engineering and Technology (IJCIET)	E-Waste and HIPS(high impact polystyrene sheet)	The values of stability obtained for the different combination of replacements has shown a result which is sufficient for the design of Dense Bituminous Macadam Roads as per MORTH which is 9 kN.
13	YateenLokesh , Rajesh Gopinath, Ishant Prasad Jaiswal, Amit Singh , Sarbartha Banerjee , and WakahikaDkhar	International Journal of Innovation and Applied Studies	E-Waste Ceramic	The study involved replacement of aggregates from 4.75 mm IS size slot from the gradation by the selected and prepared E-Waste ceramic at 0%, 5%, 10%, 15% and 20% replacement respectively. These individually were subsequently casted into Marshall Specimen for each such percentage replacement to determine the respective OBC's. Based on the OBC's obtained for both neat mix and mixes with E-Wastes ceramic, specimen were further casted, tested and compared for Marshall Strength and Physical properties. The study concluded that the Percentage replacement of Aggregate with E-Waste ceramic of size 4.75mm IS sieve could be done effectively up to 10% by weight of total aggregate mass. The 10% replacement was found to be idealistic, since it was found to give a similar and yet better results when compared to mixes casted with no ceramic replacement. In the present context of applicability, it need to be mentioned that the informal sectors that are deeply involved in e-waste recycling must evolve into more formal sectors, to ensure proper adaptation of the present developed technology.
14	Piyush G. Chandak, Anand B. Tapase, Ravindra P. Patil, Sabir S. Sayyed, Abdulrashid C. Attar	International Journal of Innovative Technology and Exploring Engineering (IJITEE)	Utilizing different waste	1) Partial substitution of aggregates by e-waste and partial substitution of bitumen by crumb rubber or plastic is technically feasible. 2) As per IS:SP:98 [13], with the dry process, plastic waste can be used to partially replace bitumen by 7% and 10% by waste rubber to form a modified bitumen in bituminous layer having 5.5% optimum bitumen content. 3) From the analysis, it can be suggested that the partial replacement of aggregates using e-waste alone is 7.5%
15	Hai-Yong Kang , Julie M. Schoenung	Resources, Conservation and Recycling 45 (2005) 368–400	E-Waste recycling	As one of the options for the diversion of EOL electronics, the recycling option is considered. To clarify the recycling option, the authors have researched the electronic recycling infrastructure in the U.S. However, because recycling of electronic waste started only recently, the methods and infrastructure for collection and processing are not yet well established. As a result, large amounts of collected electronics are exported overseas. For better recycling, an established recycling program is needed. There have been various attempts to collect e-waste or to establish take-back systems, but these are still in early stages of development.

CONCLUSION

Form the all experiment it is concluded that e-waste increased the strength. At 5% optimum bitumen content in which the replacement of 5%,10% and 15% of e-waste plastic powder with bitumen shows better strength and the 10% of the replacement can be used for the pavements. By using e-waste for the pavements e-waste management in environment can be improved. The cost can be reduced. Bitumen properties like penetration value, ductility, flash and fire point, specific gravity and softening point changes. The use of aggregates can be reduced.

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