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Assessing the Performance of RAP Based Precast Concrete Paver Block Mixes Exposed To Continuous and Intermittent Water Curing Regimes

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Extended Abstract

Gradual depletion of good quality natural aggregate sources and restrictions on quarrying activities to preserve the ecological balance has compelled researchers in the fields of construction materials to search for reliable alternative sources of supply [1,2]. In this context, reclaimed asphalt pavement (RAP) can serve as one potential solution. RAP is a recycled material generated in large amounts when deteriorated asphalt pavements are milled or demolished for repair, rehabilitation, and reconstruction activities [1,3]. Several research studies have considered the utilization of RAP for asphalt and concrete pavement applications like hot mix asphalt (HMA), Portland cement concrete (PCC), roller compacted concrete (RCC), and dry lean concrete (DLC). Successful utilization of RAP in the pavement industry can offer socio-economic and environmental benefits like safe disposal of an enormous amount of pavement solid waste, minimize the use of natural aggregate sources and pollution related to quarrying activities, and incur cost savings associated with the purchase and transportation of natural aggregates [4,5]. However, the suitability of RAP aggregates for special types of concrete applications like concrete paver blocks (CPBs) has hardly been studied. In recent decades, CPBs have attained widespread popularity for various commercial, municipal, and industrial applications due to their superior strength, durability, and aesthetic features [6]. The reduced energy requirements and carbon footprints associated with the production of these precast products have largely helped their integration into sustainable green infrastructure and low-impact development programs [7]. Additionally, studies investigating the potential of RAP as an alternative aggregate source in concrete pavement applications like PCC, RCC, and DLC have mostly considered standard curing procedures like continuous water or moist curing for evaluating the hardened concrete properties. But, precast concrete products like CPBs are either cured in the air or are subjected to a combination of water and air (intermittent water) curing because of their mass production and lack of indoor storage facilities [6,8]. Therefore, the behavior of RAP based CPB mixes when subjected to intermittent water curing condition is another research area that needs to be explored to understand the possible utilization of RAP in the precast concrete industry from an economic viewpoint.

Therefore, the main objective of the present study is to assess the performance of CPB mixes containing different RAP fractions (coarse, fine, and combined) at replacement percentages of 50 and 100% by volume of natural aggregates when subjected to continuous and intermittent water curing regimes. RAP materials used for this study were sourced from a stretch of National Highway demolished using a backhoe up to its bound base course. After demolition of the asphalt pavement, the RAP materials were milled and stockpiled in the open for six months. Preliminary visual examination showed the presence of a stiff asphalt layer and dust contaminants adhered to the surface of RAP aggregates. After being transported to the research facility, the collected RAP was initially screened through a 20 mm sieve to discard the large chunks of RAP agglomerates and then fractionated into coarse and fine fractions using a 4.75 mm sieve. Any beneficiation or processing was not performed for the RAP aggregates. Mix proportioning for the CPB mixes was performed in accordance with IS 15658 [9] and IRC SP 63 [10]. Taking cognizance of the presence of agglomerated particles in RAP and the necessity to achieve a dense microstructure, the concrete specimens were fabricated implementing a design methodology that included staged mixing of concrete ingredients and time-controlled dual-source compaction in layers.

Specimens subjected to continuous water curing were cured in a water tank for 28 days, whereas those subjected to intermittent water curing were initially cured in a water tank for 7 days and subsequently cured in the air under laboratory conditions for 21 days. The hardened concrete specimens were then tested for compressive strength, water absorption, porosity, and abrasion resistance properties as per different IS and ASTM standards.

Based on the test results and analysis, it was found that RAP aggregates can be used for fabricating different classes of CPBs applicable for medium, heavy, and very heavy traffic areas. Interestingly, CPB mixes with or without RAP exposed to intermittent water curing condition demonstrated around 3 – 12% higher compressive strength than their counterparts subjected to continuous water curing condition. Contrastingly, the water absorption, porosity, and abrasion resistance properties were superior for continuously water cured CPB mixes. Nevertheless, the test results for the above-stated properties were within the acceptable limits as per IS 15658 [9] and ASTM C936/C936M [11] for the considered CPB mixes subjected to intermittent water curing regime.

References

[1] S. E. E. B. Said, S. E. E. Khay and A. Loulizi, "Experimental investigation of PCC incorporating RAP," *Int. J. Concr. Struct. Mater.*, vol. 12, no. 1, pp. 1-11, 2018.

[2] S. Debbarma, S. Singh and G. D. Ransinchung R. N., "Laboratory investigation on the fresh, mechanical, and durability properties of roller compacted concrete pavement containing reclaimed asphalt pavement aggregates," *Transp. Res. Rec.*, vol. 2673, no. 10, pp. 652-662, 2019.

[3] X. Shi, A. Mukhopadhyay and K. W. Liu, "Mix design formulation and evaluation of portland cement concrete paving mixtures containing reclaimed asphalt pavement," *Constr. Build. Mater.*, vol. 152, pp. 756-768, 2017.

[4] X. Shi, A. Mukhopadhyay and D. Zollinger, "Sustainability assessment for portland cement concrete pavement containing reclaimed asphalt pavement aggregates," *J. Clean. Prod.*, vol. 192, pp. 569-581, 2018.

[5] S. Singh, G. D. Ransinchung R. N., S. Debbarma and P. Kumar, "Utilization of reclaimed asphalt pavement aggregates containing waste from Sugarcane Mill for production of concrete mixes," *J. Clean. Prod.*, vol. 174, pp. 42-52, 2018.

[6] N. Ghafoori and B. M. Sukandar, "Abrasion resistance of concrete block pavers," *ACI Mater. J.*, vol. 92, no. 1, pp. 25-36, 1995.

[7] C. S. G. Penteado, E. V. de Carvalho and R. C. C. Lintz, "Reusing ceramic tile polishing waste in paving block manufacturing," *J. Clean. Prod.*, vol. 112, pp. 514-520, 2016.

[8] A. Abdelbary and A. R. Mohamed, "Investigating abrasion resistance of interlocking blocks incorporating steel slag aggregate," *ACI Mater. J.*, vol. 115, no. 1, pp. 47-54, 2018.

[9] IS 15658, "Precast concrete blocks for paving – specification," *Bureau of Indian Standards*, New Delhi, India, 2006.

[10] IRC SP 63, "Guidelines for the use of interlocking concrete block pavement," *Indian Roads Congress*, New Delhi, India, 2018.

[11] ASTM C936/C936M, "Standard specification for solid concrete interlocking paving units," *American Society for Testing and Materials (ASTM International)*, West Conshohocken, PA, 2016.