INTISARI

Urban Heat Island (UHI) merupakan fenomena peningkatan suhu di wilayah perkotaan akibat perubahan karakteristik permukaan karena urbanisasi, penggunaan material buatan, serta pelepasan panas dari aktivitas manusia. Salah satu strategi mitigasinya adalah *cool pavement*, yaitu perkerasan yang dirancang untuk menurunkan suhu udara dengan mereduksi suhu permukaan perkerasan. Namun, kajian beton perkerasan kaku (*rigid pavement*) dalam konteks ini masih terbatas, khususnya dengan pemanfaatan material lokal seperti *Electric Arc Furnace Slag* (EAFS) untuk memodifikasi sifat termofisika perkerasan, salah satu pendekatan *cool pavement*. EAFS merupakan limbah industri baja yang berpotensi mencemari lingkungan, namun memiliki karakteristik fisis dan termal yang unggul.

Penelitian ini bertujuan mengkaji pengaruh substitusi agregat EAFS terhadap konduktivitas termal, performa termal, serta kekesatan permukaan (*skid resistance*) beton perkerasan kaku dengan kuat lentur 4.5 MPa. Dalam penelitian ini, benda uji divariasikan dengan substitusi EAFS sebesar 0, 25, 50, 75, dan 100% pada agregat halus dan kasar. Pengujian mencakup karakterisasi agregat, uji konduktivitas termal (QTM-500), uji performa termal dengan simulasi *heating-cooling*, dan uji *skid resistance* dengan *British Pendulum Tester*. Simulasi termal dilakukan dalam ruang tertutup menggunakan *heating box* untuk merepresentasikan fluktuasi suhu harian. Pengujian *skid resistance* dilakukan pada permukaan bawah benda uji tanpa finishing untuk mensimulasikan kondisi paling halus yang mungkin terjadi di lapangan.

Substitusi agregat EAFS pada beton meningkatkan konduktivitas termal sebesar 28.2% dengan nilai tertinggi 1.510 W/m·K (EAFS-100). Hal ini berkontribusi pada penurunan suhu permukaan atas saat siang hari hingga 4.4 °C, serta peningkatan suhu bagian bawah sebesar 1.1 °C, mengindikasikan transfer panas yang lebih efisien ke dalam struktur. Gradien suhu vertikal (ΔT) maksimum menurun hingga 8.3 °C yang berpotensi meningkatan durabilitas. Di sisi lain, *skid resistance* menurun 32.7%, dari 94.7 menjadi 63.7 BPN, tetapi seluruh variasi memenuhi batas minimum standar keselamatan. Penelitian ini membuktikan bahwa substitusi agregat EAFS pada perkerasan kaku berbasis PCC dapat menjadi solusi mitigasi UHI sekaligus aman untuk lalu lintas perkotaan.

Kata kunci: perkerasan kaku EAFS, *Urban Heat Island*, konduktivitas termal, performa termal, *skid resistance*

ABSTRACT

Urban Heat Island (UHI) is a phenomenon of rising temperatures in urban areas caused by changes in surface characteristics due to urbanization, the use of artificial materials, and heat emissions from anthropogenic activities. One promising mitigation strategy is the application of cool pavement, designed to reduce air temperatures by lowering pavement surface temperatures. However, research on rigid pavements within this context remains limited—especially with the use of local materials such as Electric Arc Furnace Slag (EAFS) to enhance the pavement's thermophysical properties, as part of cool pavement strategies. EAFS, a by-product of the steel industry, poses environmental risks if not properly managed but exhibits favorable physical and thermal characteristics.

This study aims to investigate the effects of EAFS aggregate substitution on thermal conductivity, thermal performance during heating–cooling cycles, and skid resistance of rigid pavement concrete (PCC) with a flexural strength design of 4.5 MPa. In this research, concrete specimens were prepared with 0%, 25%, 50%, 75%, and 100% substitution of both fine and coarse aggregates using EAFS. The tests involved aggregate characterization, thermal conductivity testing using QTM-500, thermal performance analysis under controlled heating–cooling simulation, and skid resistance testing using the British Pendulum Tester. The thermal simulation was carried out in a closed system using a heating box to simulate daily temperature fluctuations. Meanwhile, the skid resistance test was performed on the bottom surface of the specimen without surface finishing to represent the smoothest condition possible in real construction scenarios.

The results show that EAFS increased thermal conductivity by 28.2%, with the highest value recorded at 1.510 W/m·K (EAFS-100). This improvement reduced peak daytime surface temperature by 4.4 °C and increased by 1.1 °C at the bottom layer, indicating more efficient heat transfer. The maximum vertical temperature gradient (ΔT) also decreased by 8.3 °C, suggesting improved thermal distribution and potential enhancement in durability. These indicate more efficient heat transfer, reduced surface heat accumulation, and improved durability. However, EAFS concrete also exhibited a 0.7 °C increase in nighttime temperature retention. Regarding road safety, skid resistance decreased by 32.7%, from 94.7 to 63.7 BPN, yet all variations remained above the minimum standards. The study findings prove that EAFS aggregate substitution in PCC-based rigid pavements offers an effective solution for UHI mitigation while maintaining safety standards for urban traffic applications.

Keywords: EAFS rigid pavement, Urban Heat Island, thermal conductivity, thermal performance, skid resistance