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Evaluasi Dampak Clogging terhadap Kinerja Pendinginan Evaporasi Pervious Concrete (PC)
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INTISARI

Pervious Concrete (PC) memiliki potensi besar dalam mereduksi fenomena *Urban Heat Island* (UHI) melalui mekanisme pendinginan evaporasi atau *Evaporative Cooling* (EC). Namun, kinerja material ini sering kali menurun akibat akumulasi sedimen atau *clogging* yang menyumbat rongga pori, sehingga menghambat permeabilitas dan laju evaporasi air. Oleh karena itu, analisis mendalam mengenai dampak *clogging* terhadap performa termal PC, serta perbandingan karakteristik evaporasi pada lingkungan terkontrol dan luar ruangan, menjadi langkah penting untuk memvalidasi efektivitas pendinginan perkerasan tersebut.

Penelitian dilakukan secara eksperimental menggunakan beton normal (NC) sebagai kontrol serta dua variasi PC bergradasi agregat ASTM No. 8 (PC8) dan No. 67 (PC67). Campuran PC menggunakan *silica fume* 10% dan *superplasticizer*, dengan target *void content* 20–35%. Simulasi *clogging* dilakukan pada 0, 5, dan 10 siklus menggunakan material agregat halus berukuran kurang dari 1,18 mm. Parameter yang dianalisis meliputi *void content*, koefisien permeabilitas, laju evaporasi, *latent heat flux*, dan temperatur permukaan. Pengujian evaporasi dilakukan secara *indoor* selama 48 jam dengan *heat flux* terkontrol 1000 W/m² serta secara *outdoor* selama 7 hari.

Hasil penelitian menunjukkan bahwa peningkatan siklus *clogging* menurunkan permeabilitas PC secara nyata. Pada kondisi tanpa *clogging*, koefisien permeabilitas NC, PC8, dan PC67 masing-masing sebesar $0{,}79\times10^{-3}$, $3{,}30\times10^{-3}$, dan $3{,}84\times10^{-3}$ cm/s, kemudian turun setelah 10 siklus menjadi $0{,}04\times10^{-3}$, $0{,}06\times10^{-3}$, dan $0{,}12\times10^{-3}$ cm/s. Penurunan ini diikuti berkurangnya laju evaporasi dan *latent heat flux*, sehingga temperatur permukaan meningkat, terutama pada PC8 dan PC67 saat lampu menyala dari 43,9°C menjadi 45,8°C dan 41,5°C menjadi 44,2°C. Pengujian *outdoor* menunjukkan kecenderungan serupa dengan kondisi *indoor*, yaitu NC memiliki temperatur tertinggi, PC8 berada di tingkat menengah, dan PC67 menunjukkan temperatur terendah. Dengan demikian, PC67 memiliki performa hidrologis dan termal terbaik, meskipun efektivitas EC tetap menurun akibat *clogging*.

Kata kunci: *Pervious Concrete* (PC), *Clogging*, *Evaporative Cooling* (EC), Permeabilitas, *Urban Heat Island* (UHI).

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ABSTRACT

Pervious Concrete (PC) has great potential to reduce the Urban Heat Island (UHI) phenomenon through the Evaporative Cooling (EC) mechanism. However, its performance often declines due to sediment accumulation or clogging that blocks pore voids, thereby inhibiting permeability and water evaporation rate. Therefore, an in-depth analysis of the impact of clogging on PC thermal performance, as well as a comparison of evaporation characteristics under controlled and outdoor environments, is important to validate the cooling effectiveness of this pavement.

This study was conducted experimentally using normal concrete (NC) as the control and two PC variations with ASTM No. 8 (PC8) and No. 67 (PC67) aggregate gradations. The PC mixtures used 10% silica fume and superplasticizer, with a target void content of 20–35%. Clogging was simulated at 0, 5, and 10 cycles using fine aggregate material smaller than 1.18 mm. The analyzed parameters included void content, permeability coefficient, evaporation rate, latent heat flux, and surface temperature. Evaporation testing was performed indoors for 48 hours under a controlled heat flux of 1000 W/m² and outdoors for 7 days.

The results show that increasing clogging cycles clearly reduced PC permeability. Under unclogged conditions, the permeability coefficients of NC, PC8, and PC67 were 0.79×10^{-3}, 3.30×10^{-3}, and 3.84×10^{-3} cm/s, respectively, then decreased after 10 cycles to 0.04×10^{-3}, 0.06×10^{-3}, and 0.12×10^{-3} cm/s. This reduction was followed by lower evaporation rate and latent heat flux, resulting in higher surface temperature, particularly for PC8 and PC67 during the lamp-on period, which increased from 43.9°C to 45.8°C and from 41.5°C to 44.2°C. The outdoor test showed a similar tendency to the indoor condition, in which NC had the highest temperature, PC8 remained at an intermediate level, and PC67 showed the lowest temperature. Therefore, PC67 provided the best hydrological and thermal performance, although EC effectiveness still decreased due to clogging.

Keywords: *Pervious Concrete (PC), Clogging, Evaporative Cooling (EV), Permeability, Urban Heat Island (UHI).*