INTISARI

Pembangunan infrastruktur jalan merupakan salah satu agenda penting dalam pemenuhan pelayanan dasar, peningkatan konektivitas dan aksesibilitas. Namun, kerusakan jalan akibat beban kendaraan dan pengaruh lingkungan (suhu dan kelembaban) masih menjadi masalah utama yang dihadapi saat ini. Oleh karena itu, dibutuhkan bahan baru yang inovatif untuk membuat konstruksi jalan lebih tahan lama, ekonomis, dan efisien. Dalam penelitian ini, dilakukan sintesis kapur padam (*hydrated lime*, HL) menjadi bahan skala nano (*nano hydrated lime*, NHL) untuk dijadikan bahan subtitusi *filler* pada campuran aspal beton lapis aus (*asphalt concrete-wearing course*, AC-WC). Tujuan penelitian ini adalah untuk mengetahui efek penggunaan NHL terhadap ketahanan campuran AC-WC terhadap kerusakan akibat kelembaban.

Metode sintesis dilakukan dengan cara sonikasi selama 20 menit, dilanjutkan dengan kalsinasi pada suhu 300°C. Karakterisasi NHL dilakukan menggunakan teknik *X-ray Diffraction* (XRD), *Scanning Electron Microscopy* (SEM), dan *Energy Dispersive X-Ray* (EDX). Variasi subtitusi *filler* NHL sebesar 0%, 1%, 2%, dan 3% dari target gradasi campuran 6,5% untuk bahan pengisi. Sampel AC-WC kemudian diuji untuk mengetahui sifat mekanik campuran dengan melakukan uji Marshall dan uji *Indirect Tensile Strength* (ITS).

Berdasarkan gambar SEM dianalisis menggunakan *software* Image-J, hasil pengukuran sampel HL mengalami penurunan ukuran dari 1,88 μm menjadi 212 nm. Hasil SEM menunjukkan morfologi sampel berbentuk *amorf* dan tidak homogen, masih terdapat partikel mikro dan cenderung terjadi aglomerasi, akibatnya hasil pengujian campuran menjadi inkonsisten. Uji Marshall kondisi kadar aspal optimum (KAO) dari semua variasi menunjukkan nilai stabilitas memenuhi spesifikasi di atas 800 kg. Namun setelah dilakukan perendaman nilai stabiltas Marshall sisa (RMS) yang memenuhi spesifikasi hanya variasi NHL 0% dan 1%. Nilai RMS tertinggi 96,17% pada variasi NHL 1%, sedangkan dua variasi lainnya masih di bawah 90% (batas minimal). Hasil uji ITS menunjukkan nilai TSR semua variasi campuran memenuhi spesifikasi di atas 80% dengan nilai TSR tertinggi 82,92% pada variasi NHL 3%. Walaupun nilai TSR tertinggi pada kadar NHL 3% tetapi nilai RMS belum memenuhi spesifikasi, sehingga kadar optimum subtitusi *filler* NHL pada campuran AC-WC yang memenuhi spesifikasi yaitu variasi NHL 1% dengan KAO 5,65%. Berdasarkan hasil uji perendaman Marshall dan ITS, penggunaan NHL sebagai subtitusi *filler* pada campuran AC-WC belum memberikan pengaruh yang signifikan terhadap kekuatan campuran akibat kerentanan kelembaban.

Kata Kunci: NHL, sonikasi, kalsinasi, XRD, SEM, Marshall, ITS

ABSTRACT

The development of road infrastructure is a crucial agenda to fulfill basic services, enhance connectivity, and accessibility. However, road damage due to vehicle loads and environmental influences (temperature and moisture) is still a major problem faced today. Therefore, innovative new materials are needed to make road construction more durable, economical, and efficient. In this research, hydrated lime (HL) was synthesized into nano-scale material (nano hydrated lime, NHL) to be used as a filler replacement material in asphalt concrete-wearing course (AC-WC) mixtures. The objective of this study was to determine the effect of using NHL on the resistance of AC-WC mixtures to moisture damage.

The synthesis method was carried out by sonication for 20 minutes followed by calcination at 300°C. The characterization of NHL was performed through the implementation of X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and Energy Dispersive X-Ray (EDX) techniques. Variations of NHL filler substitution were 0%, 1%, 2%, and 3% of the target mixture gradation of 6.5% for filler. Subsequently, the mechanical properties of the mixture of AC-WC were assessed through the administration of both the Marshall and Indirect Tensile Strength (ITS) tests.

The measurement results of HL samples were estimated to be 1.88 μm, and NHL samples were estimated to be 212 nm. As revealed by the SEM results, the sample's shape appears amorphous and inhomogeneous, and there are still microparticles that tend to agglomerate. Marshall test at optimum asphalt content (KAO) for all variations shows the stability value meets specifications above 800 kg. However, after soaking, the residual Marshall stability (RMS) values that meet the specifications are only 0% and 1% NHL variations. The highest RMS value is 96.17% in the 1% NHL variation, while the other two variations are still below 90% (minimum limit). All mixture variations in the ITS test have TSR values above 80%, with the highest value of 82.92% in the 3% NHL variation. Although the highest TSR value is at 3% NHL content, the RMS value does not meet the specifications, so the optimum level of NHL filler substitution in AC-WC mixtures that meet the specifications is the 1% NHL variation with a KAO of 5.65%. Based on the results of the Marshall and ITS immersion tests, the use of NHL as a filler substitute in AC-WC mixtures has not yet had a significant effect on the strength of the mixture due to moisture susceptibility.

Keywords: NHL, sonication, calcination, XRD, SEM, Marshall, ITS