ABSTRAK

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PENGGUNAAN *LIFE CYCLE ASSESSMENT* UNTUK ANALISIS PERBANDINGAN DAMPAK LINGKUNGAN PROSES PRODUKSI ANTARA *POLYMER MODIFIED ASPHALT* (PMA) DENGAN *ASPAL POLYMER MODIFIED BITUMEN* (PMB) SKALA LABORATORIUM
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(xiv + 112 halaman; 34 tabel; 46 gambar; 6 lampiran)

Jalan raya merupakan sarana transportasi darat yang penting. Aspal merupakan salah satu bahan yang sering digunakan untuk konstruksi jalan raya. Tetapi aspal menghasilkan emisi yang berdampak negatif terhadap lingkungan. Oleh karena itu, penelitian ini bertujuan untuk menganalisis dampak lingkungan dari aspal, khususnya *Polymer Modified Asphalt* (PMA) dan *Polymer Modified Bitumen* (PMB), serta membandingkan sifat mekanis PMA dengan PMB dari uji *marshall*. PMA yang digunakan adalah *Hot Mix Asphalt* (HMA) dengan kadar polimer 5% serta 6%. Polimer PMA dicampurkan saat proses pengadukan aspal dan agregat. PMB menggunakan jenis polimer *Styrene-Butadiene-Styrene* (SBS) yang sudah tercampur di dalam aspal. Parameter sifat mekanis dan volumetrik yang dihitung pada penelitian ini adalah stabilitas, *flow*, *Marshall Quotient* (MQ), *density*, *void in mixture* (VIM), *void in mineral aggregate* (VMA), dan *void filled with bitumen* (VFB). Nilai stabilitas dan *flow* PMB lebih tinggi dibandingkan PMA. Nilai MQ, *density*, VIM, VMA, dan VFB dari PMA lebih tinggi dibandingkan PMB. Penelitian ini mengukur emisi dari PMA dan PMB dalam tiga kondisi yang berbeda yaitu ketika campuran aspal berada di oven, *mixer*, dan ditumbuk. Berdasarkan hasil uji emisi, dilakukan *life cycle assessment* menggunakan *database* European CML untuk menghitung *environmental impact*, yaitu *Global Warming Potential* (GWP), *freshwater aquatic ecotoxicity*, *Human Toxicity Potential* (HTP), *photooxidant formation potential*, dampak dari transportasi, serta penggunaan listrik. Berdasarkan hasil pengujian, HMA dengan polimer 5% menghasilkan emisi terendah dan PMB tertinggi. HMA dengan polimer 5% memiliki *environmental impact* terkecil dan PMB terbesar. Jika dibandingkan dengan HMA polimer 5%, PMB menghasilkan GWP 3,12% lebih kecil, *freshwater aquatic ecotoxicity* 21,15% lebih besar, HTP 30,91% lebih besar, dan *photooxidant formation potential* 30,92% lebih besar. HMA dengan penambahan polimer 6% memberikan dampak terhadap lingkungan yang paling besar pada transportasi material sedangkan PMB memberikan dampak terkecil pada transportasi material dengan perbedaan 0,75% hingga 25%. Total energi listrik yang digunakan PMB lebih besar 3,1% dibandingkan dengan PMA.

Kata Kunci : Emisi, *Environmental Impact, Hot Mix Asphalt, Life Cycle Assessment, Polymer Modified Bitumen*
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ABSTRACT

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UTILIZATION OF LIFE CYCLE ASSESSMENT FOR ENVIRONMENTAL IMPACT ANALYSIS OF PRODUCTION PROCESS BETWEEN POLYMER MODIFIED ASPHALT (PMA) AND POLYMER MODIFIED BITUMEN (PMB) LABORATORIUM SCALE

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The road is a mean of land transportation that plays an important role. Asphalt is one of the materials that is often used for road construction. However, asphalt produces emissions that have negative impacts on the environment. Therefore, this study aims to analyze the environmental impact of asphalt, specifically Polymer Modified Asphalt (PMA) and Polymer Modified Bitumen (PMB), also compares the mechanical properties of PMA and PMB through marshall test. In this study, the PMA used is Hot Mix Asphalt (HMA) with a polymer content of 5% and a polymer content of 6%. The polymer in PMA is mixed during the asphalt and aggregate mixing process. PMB uses Styrene-Butadiene-Styrene (SBS) polymer which has been mixed in the asphalt. The mechanical and volumetric properties calculated in this study are stability, flow, Marshall Quotient (MQ), density, void in mixture (VIM), void in mineral aggregate (VMA), and void filled with bitumen (VFB). Stability and flow of PMB is higher than PMA. MQ, density, VIM, VMA, and VFB of PMA is higher than PMB. This study also calculates the emissions of PMA and PMB in three different conditions, namely when the asphalt mixture was in the oven, in the mixer, and when it was pounded. Based on the emission test results, life cycle assessment using European CML database was carried out to calculate the environmental impacts, such as Global Warming Potential (GWP), freshwater aquatic ecotoxicity, Human Toxicity Potential (HTP), photooxidant formation potential, impacts of material transportation, and electrical energy usage. Based on the test results, HMA with 5% polymer has the lowest environmental impact and PMB has the highest environmental impact. When compared with HMA with 5% polymer, PMB produces 3.12% less GWP, 21.15 % greater freshwater aquatic ecotoxicity, 30.91% greater HTP, and 30.92% greater photooxidant potential. HMA with 6% polymer has the greates environmental impact for material transportation, while PMB has the smallest impact, the difference in environmental impact ranges from 0.75% to 25%. The total electrical energy used for PMB is 3.1% greater than PMA.

Keywords : Emission, Environmental Impact, Hot Mix Asphalt, Life Cycle Assessment, Polymer Modified Bitumen

References : 59 (1997-2022)