UNIVERSITAS
GADJAH MADA
Pengaruh Penggunaan Aspal Modifikasi Bio-oil Tandan Kosong Kelapa Sawit pada Campuran AC-WC terhadap Pengujian Indirect tensile Strength (ITS)
CINDY CLAUDIA IVANY MAYAUT, Ir. Latif Budi Suparma, M.Sc., Ph.D ; Ir. Suprapto Siswosukarto, Ph.D., IPM
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

INTISARI

Perkerasan jalan beraspal harus memiliki kinerja struktural dan fungsional yang baik agar mampu menahan beban lalu lintas serta pengaruh lingkungan. Salah satu permasalahan yang sering terjadi adalah retak akibat kelelahan (*fatigue*) dan deformasi permanen (*rutting*) yang dipengaruhi oleh beban berulang, suhu tinggi, dan kelembapan. Salah satu upaya untuk meningkatkan kinerja campuran aspal sekaligus mendukung pemanfaatan limbah biomassa adalah penggunaan *bio-oil* tandan kosong kelapa sawit sebagai bahan modifikasi aspal. Penelitian ini bertujuan mengevaluasi pengaruh penggunaan *bio-oil* tandan kosong kelapa sawit terhadap parameter perancangan campuran *Asphalt Concrete-Wearing Course* penetrasi 60/70, ketahanan terhadap pengaruh air berdasarkan pengujian *Indirect Tensile Strength*, serta potensi *rutting*.

Penelitian menggunakan metode eksperimental melalui pengujian laboratorium yang meliputi karakteristik agregat, penentuan kadar aspal optimum, pengujian Marshall, *Marshall Immersion*, dan *Indirect Tensile Strength*. Variasi kadar *bio-oil* yang digunakan adalah 0%, 5%, 10%, dan 15% terhadap berat aspal. Pengujian *Indirect Tensile Strength* dilakukan pada kondisi *unconditioned*, *conditioned*, dan suhu 40°C sebagai indikator potensi *rutting*.

Hasil penelitian menunjukkan bahwa penambahan *bio-oil* tandan kosong kelapa sawit memengaruhi parameter perancangan campuran, ditunjukkan oleh nilai kadar aspal optimum sebesar 5,6%; 6,3%; 6,0%; dan 5,8% untuk kadar *bio-oil* 0%, 5%, 10%, dan 15%. Campuran dengan penambahan 10% *bio-oil* menghasilkan nilai *Indirect Tensile Strength* tertinggi, yaitu 1174 kPa pada kondisi *unconditioned* dan 1039 kPa pada kondisi *conditioned*, dengan nilai *Tensile Strength Ratio* sebesar 88,52% yang memenuhi Spesifikasi Umum Bina Marga 2018 (Revisi 2). Sementara itu, hasil pengujian *Indirect Tensile Strength* pada suhu 40°C menunjukkan bahwa campuran dengan 10% *bio-oil* memiliki nilai *Indirect Tensile Strength* tertinggi, yang mengindikasikan potensi *rutting* paling rendah. Secara keseluruhan, penggunaan *bio-oil* tandan kosong kelapa sawit sebagai bahan modifikasi aspal berpotensi meningkatkan kinerja campuran *Asphalt Concrete-Wearing Course* serta mendukung pengembangan perkerasan jalan yang lebih berkelanjutan melalui pemanfaatan limbah industri kelapa sawit.

Kata kunci: tandan kosong kelapa sawit, *bio-oil* TKKS, ITS, TSR, potensi *rutting.*

UNIVERSITAS
GADJAH MADA
Pengaruh Penggunaan Aspal Modifikasi Bio-oil Tandan Kosong Kelapa Sawit pada Campuran AC-WC terhadap Pengujian Indirect tensile Strength (ITS)
CINDY CLAUDIA IVANY MAYAUT, Ir. Latif Budi Suparma, M.Sc., Ph.D ; Ir. Suprapto Siswosukarto, Ph.D., IPM
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

ABSTRACT

Asphalt pavements must possess adequate structural and functional performance to withstand traffic loading and environmental effects throughout their service life. One of the most common forms of pavement distress is fatigue cracking and permanent deformation (rutting), which are primarily induced by repeated traffic loading, elevated temperatures, and moisture exposure. One approach to improving the performance of asphalt mixtures while promoting the utilization of biomass waste is the incorporation of bio-oil derived from oil palm empty fruit bunches (OPEFB) as an asphalt modifier. This study aimed to evaluate the effect of OPEFB bio-oil on the mix design parameters of 60/70 penetration grade Asphalt Concrete-Wearing Course (AC-WC), its resistance to moisture damage based on the Indirect Tensile Strength (ITS) test, and its rutting potential.

An experimental laboratory investigation was conducted, including aggregate characterization, determination of the optimum asphalt content (OAC), Marshall testing, Marshall immersion testing, and Indirect Tensile Strength (ITS) testing. Bio-oil contents of 0%, 5%, 10%, and 15% by weight of asphalt binder were evaluated. The ITS test was performed under unconditioned and conditioned moisture conditions, as well as at a temperature of 40°C to assess rutting potential.

The results indicated that the incorporation of OPEFB bio-oil influenced the mix design parameters, as reflected by optimum asphalt contents of 5.6%, 6.3%, 6.0%, and 5.8% for bio-oil contents of 0%, 5%, 10%, and 15%, respectively. The mixture containing 10% OPEFB bio-oil exhibited the highest Indirect Tensile Strength values, reaching 1174 kPa under unconditioned conditions and 1039 kPa under conditioned conditions, with a Tensile Strength Ratio (TSR) of 88.52%, satisfying the requirements of the 2018 General Specifications for Highways of Bina Marga (Revision 2). Furthermore, the ITS test conducted at 40°C demonstrated that the mixture containing 10% OPEFB bio-oil achieved the highest ITS value, indicating the lowest rutting potential. Overall, the use of OPEFB bio-oil as an asphalt modifier has the potential to enhance the performance of Asphalt Concrete-Wearing Course mixtures while supporting the development of more sustainable pavement systems through the utilization of oil palm industry biomass waste.

Keywords: oil palm empty fruit bunches; bio-oil TKKS; ITS; TSR; rutting potential.