ABSTRAK

IDENTIFIKASI ZONA PENURUNAN TANAH MENGGUNAKAN METODE *GROUND PENETRATING RADAR* (GPR) PADA RUAS JALAN TOL BINJAI, SUMATERA UTARA

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Penurunan tanah pada ruas Jalan Tol Binjai, Sumatera Utara, berpotensi menyebabkan penurunan jalan, retakan, serta menurunkan kenyamanan dan keselamatan pengguna jalan. Penurunan tanah dipengaruhi oleh kondisi tanah dasar, beban lalu lintas, dan ketidakseragaman material timbunan. Metode GPR digunakan karena mampu mengidentifikasi kondisi bawah permukaan secara *non-destruktif* melalui analisis pola reflektor, amplitudo, dan kontinuitas lapisan. Penelitian ini bertujuan mengidentifikasi zona penurunan tanah urugan berdasarkan karakteristik reflektor radargram serta memvisualisasikan sebaran deformasi bawah permukaan secara spasial.

Pengukuran dilakukan menggunakan GPR GSSI SIR-3000 tipe *shielded* dengan antena frekuensi 100 MHz pada 36 lintasan di sekitar jembatan layang Jalan Tol Binjai. Panjang lintasan berkisar antara 11–12 meter dan 24 meter dengan orientasi utara–selatan serta barat–timur. Data radargram hasil pengukuran GPR diproses menggunakan *static correction, subtract mean-dewow, bandpass butterworth, AGC-gain, running average,* dan *time depth correction* untuk meningkatkan kualitas refleksi bawah permukaan. Interpretasi dilakukan berdasarkan perubahan geometri reflektor, kontinuitas lapisan, dan variasi amplitudo. Korelasi antarpenampang dilakukan melalui *horizon interpretation* dan pemetaan kedalaman menggunakan interpolasi *Inverse Distance Weighted* (IDW) pada perangkat lunak *Geolitix.*

Hasil penelitian menunjukkan bahwa zona penurunan tanah urugan ditandai oleh reflektor melengkung ke bawah, dan reflektor tidak kontinu. Deformasi penurunan tanah urugan teridentifikasi pada kedalaman sekitar 0,1–0,23 meter, dengan zona dominan berada pada bagian tenggara dan barat area penelitian. Lintasan 1, 15, dan 35 menunjukkan penurunan tanah paling dominan dibandingkan lintasan lainnya. Hasil penelitian menunjukkan bahwa metode GPR efektif untuk mengidentifikasi penurunan tanah urugan dan memvisualisasikan kondisi bawah permukaan jalan tol secara spasial dan *non-destruktif* dengan tingkat interpretasi data yang baik.

Kata kunci: *Ground Penetrating Radar* (GPR), penurunan tanah urugan, radargram, jalan tol, tanah urugan.

ABSTRACT

IDENTIFICATION OF LAND SUBSIDENCE ZONES USING THE GROUND PENETRATING RADAR (GPR) METHOD ON THE BINJAI TOLL ROAD SECTION, NORTH SUMATRA

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Land subsidence along the Binjai Toll Road, North Sumatra, has the potential to cause pavement settlement, cracking, and reduced comfort and safety for road users. This phenomenon is influenced by subgrade conditions, traffic loads, and the heterogeneity of embankment materials. Ground Penetrating Radar (GPR) was employed in this study because it is capable of identifying subsurface conditions non-destructively through the analysis of reflector patterns, amplitudes, and layer continuity. This study aims to identify land subsidence zones based on radargram reflector characteristics and to spatially visualize the distribution of subsurface deformation.

Data acquisition was carried out using a GSSI SIR-3000 shielded GPR system equipped with a 100 MHz antenna along 36 survey lines around the overpass section of the Binjai Toll Road. The survey lines had lengths ranging from 11–12 m and 24 m, with north–south and west–east orientations. Radargram data were processed using static correction, subtract mean-dewow, bandpass Butterworth, AGC gain, running average, and time-depth correction to improve the quality of subsurface reflections. Interpretation was performed based on reflector geometry changes, layer continuity, and amplitude variations. Correlation between radargram profiles was conducted through horizon interpretation, followed by depth mapping using Inverse Distance Weighted (IDW) interpolation in Geolitix software.

The results show that subsidence zones are characterized by downward-curving reflectors and discontinuous reflectors. Subsidence deformation was identified at depths of approximately 0.1–0.23 m, with the dominant zones located in the southeastern and western parts of the study area. Survey Lines 1, 15, and 35 exhibited the most prominent subsidence compared to the other survey lines. These findings indicate that the GPR method is effective for identifying land subsidence and spatially visualizing subsurface conditions of toll roads in a non-destructive manner, with a good level of interpretation reliability.

Keywords: Ground Penetrating Radar, land subsidence, toll road, radargram, deformation, Binjai Toll Road