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STUDI EKSPERIMENTAL PENGARUH GEOMETRI PENAMPANG TERHADAP KAPASITAS LENTUR ELEMEN STRUKTURAL RINGAN BERBASIS MELTED LOW VALUE PLASTIC
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INTISARI

Material *melted low-value plastic* (mLVP) merupakan material hasil daur ulang limbah plastik bernilai rendah yang berpotensi dikembangkan sebagai elemen struktural ringan. Salah satu upaya untuk meningkatkan performa lenturnya adalah melalui optimasi geometri penampang. Penelitian ini bertujuan menganalisis pengaruh variasi geometri penampang terhadap kapasitas lentur, perilaku beban-lendutan (*load-displacement*), kekakuan lentur, mode kegagalan, serta mengevaluasi kemampuan model numerik berbasis *Finite Element Method* (FEM) dalam merepresentasikan respons lentur elastis elemen mLVP.

Penelitian dilakukan secara eksperimental menggunakan metode three-point bending terhadap sembilan benda uji yang terdiri atas tiga variasi geometri penampang, yaitu balok solid, profil IWF, dan profil C. Selain itu, dilakukan analisis teoritis terhadap parameter geometri penampang serta simulasi numerik menggunakan ABAQUS dengan asumsi material homogen dan linear elastis untuk memvalidasi respons lentur elastis terhadap hasil eksperimen.

Hasil penelitian menunjukkan bahwa variasi geometri penampang berpengaruh terhadap perilaku lentur elemen mLVP. Profil C menghasilkan kapasitas lentur rata-rata tertinggi sebesar 0,435 kN·m dan kekakuan rata-rata sebesar 1,601 kN/mm, sedangkan profil IWF menghasilkan rasio efisiensi material tertinggi sebesar $1{,}84 \times 10^{-4}$ kN·m/mm² serta lendutan ultimit rata-rata terbesar sebesar 3,94 mm. Seluruh benda uji mengalami kegagalan lentur yang ditandai dengan terbentuknya retak vertikal pada daerah tarik di sekitar tengah bentang. Hasil validasi menunjukkan bahwa simulasi numerik memiliki deviasi sebesar 6,9% terhadap hasil teoritis, namun deviasi mencapai 97,8% terhadap hasil eksperimen. Perbedaan tersebut menunjukkan bahwa model numerik dengan asumsi material homogen dan linear elastis belum mampu merepresentasikan perilaku aktual material mLVP akibat pengaruh ketidakhomogenan material, variasi kepadatan, keberadaan void, dan ketidakteraturan hasil fabrikasi.

Kata kunci: *melted low-value plastic*, geometri penampang, kapasitas lentur, *three-point bending*, simulasi numerik, ABAQUS

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ABSTRACT

Melted low-value plastic (mLVP) is a recycled material produced from low-value plastic waste that has the potential to be developed as a lightweight structural element. One approach to improving its flexural performance is through cross-sectional geometry optimization. This study aims to investigate the influence of cross-sectional geometry on flexural capacity, load-displacement behavior, flexural stiffness, failure mode, and to evaluate the capability of a Finite Element Method (FEM)-based numerical model in representing the elastic flexural response of mLVP elements.

An experimental study was conducted using the three-point bending method on nine specimens with three different cross-sectional geometries: solid beam, IWF profile, and C profile. Theoretical analyses of cross-sectional properties were also performed, followed by numerical simulations using ABAQUS under homogeneous and linear elastic material assumptions to validate the elastic flexural response against experimental results.

The results indicate that cross-sectional geometry significantly influences the flexural behavior of mLVP elements. The C profile exhibited the highest average flexural capacity of 0.435 kN·m and the highest average flexural stiffness of 1.601 kN/mm. Meanwhile, the IWF profile achieved the highest material efficiency ratio of 1.84×10^{-4} kN·m/mm² and the largest average ultimate deflection of 3.94 mm. All specimens experienced flexural failure characterized by vertical cracks developing in the tension zone near the midspan. Numerical validation showed a deviation of 6.9% from the theoretical solution but a deviation of 97.8% from the experimental results. These findings indicate that the numerical model based on homogeneous and linear elastic assumptions is unable to accurately represent the actual behavior of mLVP due to material heterogeneity, density variations, internal voids, and fabrication imperfections.

Keywords: melted low-value plastic, cross-sectional geometry, flexural capacity, three-point bending, numerical simulation, ABAQUS