INTISARI

Penggunaan *bio-filler* seperti kitosan dalam matriks resin fotopolimer menawarkan potensi pengembangan material komposit ringan dan ramah lingkungan untuk aplikasi struktur penyerap energi. Penelitian ini bertujuan untuk mengevaluasi sifat-sifat mekanis material komposit resin-kitosan dan aplikasinya pada struktur *honeycomb* melalui pendekatan numerik Metode Elemen Hingga. Simulasi dilakukan menggunakan perangkat lunak Abaqus/CAE dengan memodelkan material sebagai kontinum homogen isotropik. Meskipun karakterisasi mekanis meliputi pengujian tarik dan lentur, properti input material dikalibrasi secara spesifik menggunakan data eksperimental uji lentur sesuai standar ASTM D790 guna mengakomodasi perilaku ketidaksimetrian tarik-tekan (*tension-compression asymmetry*) yang umum terjadi pada polimer. Validasi model kemudian dilakukan secara bertingkat, dimulai dari simulasi karakterisasi material yang mengacu pada standar ASTM D638 dan ASTM D790 hingga simulasi uji lentur tiga titik pada struktur *honeycomb*. Variasi fraksi massa kitosan yang dikaji meliputi 0%, 2%, 4%, 6%, 8%, dan 10% untuk karakterisasi material, serta difokuskan pada variasi 0%, 6%, dan 10% untuk analisis struktur. Hasil validasi menunjukkan model numerik mampu memprediksi respons mekanis dengan baik, di mana galat validasi bervariasi dalam batas keberterimaan di bawah 5% untuk karakterisasi material, dan mencapai akurasi tinggi dengan galat di bawah 1% pada simulasi struktur *honeycomb*. Pada simulasi karakterisasi material, model berhasil menangkap fenomena patah makroskopis lurus (*clean break*) pada uji tarik, serta perilaku deformasi lentur yang besar tanpa mengalami kepatahan pada uji lentur. Sementara itu, analisis pada struktur *honeycomb* mengungkapkan bahwa penambahan kitosan hingga 10% mampu meningkatkan kekakuan dan kekuatan tanpa memicu kegagalan instabilitas dini. Mekanisme kegagalan struktur teridentifikasi dipicu oleh pembentukan sendi plastis (*plastic hinges*) pada dinding sel yang merambat menjadi deformasi lipatan (*folding*) global. Penelitian ini membuktikan bahwa penggunaan elemen cangkang (*shell element*) tipe S4R efektif untuk memprediksi perilaku mekanis, baik pada tingkat material maupun struktural.

Kata kunci: Biokomposit, Resin Fotopolimer, Kitosan, Struktur *Honeycomb*, Metode Elemen Hingga, Abaqus.

ABSTRACT

The utilization of bio-fillers such as chitosan in photopolymer resin matrices offers potential for developing lightweight and sustainable composite materials for energy-absorbing structures. This study aims to evaluate the mechanical properties of resin-chitosan composites and their application in *honeycomb* structures using a numerical Finite Element Method approach. Simulations were conducted using Abaqus/CAE software by modeling the material as an isotropic homogeneous continuum. Although mechanical characterization included both tensile and flexural tests, material property input was specifically calibrated using flexural test data in accordance with ASTM D790 standards to accommodate the tension-compression asymmetry behavior inherent in polymers. Model validation was performed in stages, ranging from material characterization simulations based on ASTM D638 and ASTM D790 standards to three-point bending simulations of *honeycomb* structures. The chitosan mass fraction variations studied included 0%, 2%, 4%, 6%, 8%, and 10% for material characterization, with a specific focus on 0%, 6%, and 10% variations for structural analysis. Validation results demonstrated that the numerical model could predict mechanical response with good agreement, where validation errors varied within acceptable limits below 5% for material characterization, and achieved high accuracy with errors below 1% in *honeycomb* structure simulations. In material characterization simulations, the model successfully captured the clean break macroscopic fracture phenomenon in tensile tests, as well as the large deformation behavior without fracture in flexural tests. Meanwhile, analysis of the *honeycomb* structure revealed that adding chitosan up to 10% enhanced structural stiffness and strength without triggering premature instability failure. The structural failure mechanism was identified as being triggered by the formation of plastic hinges on cell walls, propagating into global folding deformation. This study proves that the usage of S4R *shell* elements is effective for predicting mechanical behavior at both material and structural levels.

Keywords: Biocomposite, Photopolymer Resin, Chitosan, *Honeycomb* Structure, Finite Element Method, Abaqus.