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Perancangan Rumah Hunian Berbahan Dasar Glubam (Glue Laminated Bamboo) Dengan Sistem Konstruksi Knockdown
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INTISARI

Sektor bangunan dan konstruksi menyumbang sekitar 21% emisi gas rumah kaca global sehingga diperlukan material yang lebih ramah lingkungan. Bambu laminasi merupakan material terbarukan yang berpotensi digunakan secara struktural. Penggunaan bambu petung sebagai bahan utama konstruksi didasarkan pada laju pertumbuhannya yang sangat cepat ($\pm$5 tahun) serta keawetan alami dan dimensinya yang besar, yang kemudian diolah menjadi bambu laminasi guna mengatasi variasi dimensi bambu utuh sehingga menghasilkan material rekayasa berpresisi tinggi, berkerapatan seragam, dan memiliki sifat mekanis yang unggul. Di samping itu, penggunaan sistem knockdown berprinsip Design for Disassembly menawarkan kebaruan dalam kemudahan perakitan, relokasi, dan pemanfaatan ulang elemen struktur. Meskipun pengintegrasian sistem ini menawarkan rancangan bangunan yang presisi, fleksibel, dan minim dampak lingkungan, kajian komprehensif mengenai perancangan strukturnya secara keseluruhan meliputi kelayakan elemen, kapasitas sambungan, dan perilakunya terhadap kombinasi beban standar (mati, hidup, angin, dan gempa) masih sangat terbatas.

Untuk mengisi celah penelitian tersebut, studi ini merumuskan masalah yang memfokuskan pada perancangan struktur secara holistik, meliputi perilaku dinamik struktur berdasarkan SNI 1726:2019, perancangan elemen batang, perancangan sambungan antar elemen, dan perancangan struktur bawah. Tujuan perancangan adalah mengetahui perilaku dinamik struktur serta memperoleh konfigurasi dan dimensi elemen struktur atas dan bawah rumah bambu laminasi. Metode perancangan diawali studi literatur, pengumpulan data sekunder sifat fisis dan mekanis bambu laminasi, pengolahan statistik berbasis persentil ke-5 dan batas kepercayaan bawah 95%, pemodelan SAP2000 dengan tiga variasi model, serta pembebanan mati, hidup, angin, dan gempa dengan data tanah acuan wilayah Yogyakarta. Teknik analisis data meliputi analisis ragam dan partisipasi massa, kontrol simpangan antar lantai, kontrol lendutan berdasarkan Eurocode 5, pengecekan kapasitas penampang dan sambungan melalui rasio *demand-capacity* (DCR), serta perhitungan struktur bawah.

Hasil menunjukkan model lengkap dengan rangka *stud* dan panel OSB memiliki periode ragam pertama 0,286 detik dan partisipasi massa melampaui 90% pada ragam ke-85. Simpangan antar lantai terbesar 1,927% pada arah Y, di bawah batas 2%. Seluruh elemen batang, delapan tipe sambungan, dan sambungan *base plate* memiliki DCR kurang dari 1,0 serta memenuhi batas lendutan. Struktur bawah berupa kolom pedestal 360×360 mm, *sloof* 200×300 mm, dan fondasi telapak 800×800 mm dinyatakan aman. Dengan demikian, rancangan rumah glubam sistem *knockdown* ini aman dan layak dikaji lebih lanjut.

Kata kunci: Bambu laminasi, Glubam, Sistem pasang urai, Sambungan pelat sisip, Sambungan tersembunyi , Perilaku dinamik

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ABSTRACT

The building and construction sector contributes approximately 21% of global greenhouse gas emissions, necessitating more environmentally friendly materials. Laminated bamboo is a renewable material with the potential for structural use. The use of petung bamboo as the primary construction material is based on its very fast growth rate (±5 years), natural durability, and large dimensions, which is then processed into laminated bamboo to overcome the dimensional variations of whole bamboo, resulting in a highly precise, uniformly dense engineered material with superior mechanical properties. Additionally, the use of a knockdown system based on the Design for Disassembly principle offers novelty in the ease of assembly, relocation, and reuse of structural elements. Although the integration of this system offers a building design that is precise, flexible, and has minimal environmental impact, comprehensive studies regarding its overall structural design including element feasibility, connection capacity, and its behavior under standard load combinations (dead, live, wind, and earthquake) are still very limited.

To fill this research gap, this study formulates a problem focused on holistic structural design, which includes the dynamic behavior of the structure based on SNI 1726:2019, the design of frame elements, the design of connections between elements, and the design of the substructure. The design objective is to determine the structure's dynamic behavior and to obtain the configurations and dimensions of the upper and lower structural elements of the laminated bamboo house. The design method began with a literature study, collection of secondary data on the physical and mechanical properties of laminated bamboo, statistical processing based on the 5th percentile and a 95% lower confidence limit, SAP2000 modeling with three model variations, and dead, live, wind, and earthquake loading using reference soil data for the Yogyakarta region. Data analysis techniques included modal and mass participation analysis, inter-story drift control, deflection control based on Eurocode 5, checking cross-sectional and connection capacities through the demand-capacity ratio (DCR), and substructure calculations.

The results show that the complete model with stud framing and OSB panels has a first-mode period of 0.286 seconds and mass participation exceeding 90% at the 85th mode. The maximum story drift is 1.927% in the Y direction, below the 2% limit. All members, eight connection types, and the base plate connection have a DCR below 1.0 and satisfy the deflection limit. The substructure, comprising 360 × 360 mm pedestal columns, 200 × 300 mm sloof beams, and 800 × 800 mm footings, is declared safe. Therefore, the knockdown glubam house design is safe and feasible for further study.

Keywords: Laminated bamboo, Glubam, Knockdown, Inserted plate connection, Concealed connection, Dynamic behavior