

ABSTRACT

The increasing demand for wood has encouraged the development of laminated bamboo as a sustainable alternative material. The production process of laminated bamboo requires a reliable bamboo splitting machine; however, during the operation of a portable bamboo slicing machine, failure occurred in the form of a fractured pillow block housing in the transmission system. This study aims to analyze the failure mechanism of the pillow block using the Finite Element Analysis (FEA) method and to propose a safer design recommendation under operational loading conditions.

The research was conducted through material composition testing using Optical Emission Spectroscopy (OES), load calculations, geometric modeling using Autodesk Inventor, and static, dynamic, and fatigue simulations using ANSYS. The housing material was identified as gray cast iron, corresponding closely to ASTM A48 Class 30. The analysis was performed on the original failed UCP 206 ABC pillow block, the replacement UCP 206 ASB, and an alternative UCF 206 design.

The results show that the UCP 206 ABC pillow block failed due to dynamic and fatigue loading, with a fatigue safety factor of 0.58895. Critical stress concentration areas were identified at the grease hole, upper housing region, and the transition between housing and base support. Under full-load conditions, both UCP 206 ASB and UCF 206 were unable to satisfy safety requirements since their fatigue safety factors remained below 1. After operational load limitation based on bamboo thickness, the UCP 206 ASB remained safe for bamboo thickness up to 20 mm with a fatigue safety factor of 1.43, while the UCF 206 design achieved a fatigue safety factor of 1.7 and was capable of operating safely up to 30 mm bamboo thickness, making it the most recommended design. Overall, the design improvements effectively reduced stress concentration and enhanced the fatigue resistance of the pillow block under operational loading conditions.

Keywords: fatigue, Finite Element Analysis, laminated bamboo, pillow block.

INTISARI

Meningkatnya kebutuhan kayu mendorong pemanfaatan bambu laminasi sebagai material alternatif yang ramah lingkungan. Proses produksi bambu laminasi membutuhkan mesin pembelah bambu yang andal, namun pada pengoperasian mesin bilah bambu portabel ditemukan kegagalan berupa pecahnya *housing pillow block* pada sistem transmisi. Penelitian ini bertujuan untuk menganalisis penyebab kegagalan *pillow block* menggunakan metode *Finite Element Analysis* (FEA) serta menentukan rekomendasi desain yang lebih aman terhadap pembebanan operasi.

Penelitian dilakukan melalui pengujian komposisi material menggunakan *Optical Emission Spectroscopy* (OES), perhitungan pembebanan, pemodelan geometri menggunakan *Autodesk Inventor*, serta simulasi statis, dinamis, dan *fatigue* menggunakan ANSYS. Material *housing* teridentifikasi sebagai *gray cast iron* yang mendekati ASTM A48 Class 30. Simulasi dilakukan pada *pillow block* awal tipe UCP 206 ABC, *pillow block* pengganti UCP 206 ASB, dan rancangan alternatif tipe UCF 206.

Hasil penelitian menunjukkan bahwa *pillow block* UCP ABC mengalami kegagalan akibat pembebanan dinamis dan *fatigue* dengan *fatigue safety factor* sebesar 0,58895. Area kritis terletak pada *grease hole*, sisi atas *housing*, dan daerah transisi *housing* terhadap kaki penopang. Pada kondisi *full load* mesin, UCP 206 ASB dan UCF 206 juga belum memenuhi kriteria keamanan karena *fatigue safety factor* masih di bawah 1. Setelah dilakukan pembatasan operasi, UCP 206 ASB masih aman digunakan hingga ketebalan bambu 20 mm dengan *fatigue safety factor* sebesar 1,43, sedangkan tipe UCF mampu bekerja hingga ketebalan bambu 30 mm dengan *fatigue safety factor* sebesar 1,7 sehingga direkomendasikan sebagai desain pengganti. Perbaikan desain terbukti mampu menurunkan konsentrasi tegangan dan meningkatkan ketahanan *pillow block* terhadap pembebanan operasi.

Kata kunci: bambu laminasi, *fatigue*, *Finite Element Analysis*, *pillow block*.