

## ABSTRACT

*The development of electric motorcycle battery swapping stations is currently hindered by the scarcity and high cost of commercial battery housing units, which serve as essential structural supports for batteries during station operations. Consequently, this study aims to design, analyze the mechanical strength (static, fatigue, and impact), predict wear depth, and validate the design through the fabrication of a steel physical prototype. Mechanical strength and wear depth analyses were conducted using the Finite Element Method (FEM). A numerical evaluation was performed on six design variations, combining different plate thicknesses (1.2 mm, 1.5 mm, and 2 mm) and material types (ASTM A36 and AISI 316) using Ansys 2025 R2 software. Simulation results indicate that plate thickness is the most dominant factor influencing structural resistance. Variation 5 (2 mm thickness, ASTM A36) emerged as the safest design, exhibiting a static safety factor (SF) of 4.9, fatigue life within the high-cycle fatigue range, and the best dynamic impact resistance with an SF of 2.6. Conversely, the 1.2 mm plate design was found to be prone to failure under impact loading. Regarding frictional analysis, the wear depth for all variations remained within the  $10^{-6}$  mm. AISI 316 was proven to be more wear-resistant than ASTM A36 due to its higher material hardness, while the 2 mm plate thickness was most effective at reducing wear due to higher structural stiffness. Fabrication of the physical prototype for Variation 5 showed dimensional consistency at most measurement locations, despite 1–2 mm variances observed in certain areas due to the manufacturing process. The prototype also successfully passed mechanical functionality and electrical socket connectivity tests. Overall, this design has proven to be robust, functional, and suitable for application as an alternative to commercial battery housing.*

*Keyword: Battery housing, battery swapping station, finite element method, safety factor, fatigue life, wear depth.*

## INTISARI

Pengembangan stasiun penukaran baterai motor listrik saat ini terkendala oleh unit rumah baterai komersial yang sulit diperoleh dan harganya yang relatif tinggi. Komponen ini memiliki peran sebagai struktur penopang baterai dalam operasional stasiun. Oleh karena itu, penelitian ini bertujuan untuk merancang, menganalisis kekuatan mekanis (statis, *fatigue*, dan dampak), memprediksi kedalaman keausan, serta memvalidasi hasil rancangan melalui pembuatan prototipe fisik berbahan baja. Analisis kekuatan mekanis dan kedalaman keausan menggunakan Metode Elemen Hingga (MEH). Evaluasi numerik dilakukan terhadap 6 variasi desain yang mengombinasikan ketebalan pelat (1,2 mm; 1,5 mm; 2 mm) dan jenis material (ASTM A36 dan AISI 316) menggunakan perangkat lunak Ansys 2025 R2. Hasil simulasi menunjukkan bahwa ketebalan pelat memberikan pengaruh paling dominan terhadap ketahanan struktur. Variasi 5 (tebal 2 mm, ASTM A36) merupakan desain paling aman dengan *safety factor* (SF) statis sebesar 4,9, *fatigue life* yang tergolong aman pada rentang *high cycle fatigue*, serta ketahanan dampak dinamis terbaik dengan SF sebesar 2,6. Sebaliknya, desain pelat setebal 1,2 mm terindikasi rawan gagal saat menahan beban dampak. Pada analisis gesekan, kedalaman keausan seluruh variasi berada di kisaran  $10^{-6}$  mm. Material AISI 316 terbukti lebih tahan aus dibandingkan ASTM A36 karena tingginya nilai kekerasan material, sementara pelat setebal 2 mm paling efektif mereduksi keausan berkat tingginya kekakuan struktur. Pembuatan prototipe fisik untuk Variasi 5 menunjukkan kesesuaian dimensi di sebagian beberapa lokasi pengukuran, meskipun terdapat perbedaan 1–2 mm di beberapa lokasi akibat proses manufaktur. Prototipe ini juga berhasil melalui uji fungsionalitas mekanis dan konektivitas soket kelistrikan. Secara keseluruhan, desain ini terbukti kuat, fungsional, dan layak diaplikasikan sebagai alternatif pengganti rumah baterai komersial.

Kata kunci: Rumah baterai, stasiun penukaran baterai, metode elemen hingga, *safety factor*, *fatigue life*, kedalaman keausan.