**[Research Background and Objectives]**

Logistics robot platforms comprise a range of machinery and equipment designed to automate and enhance efficiency in logistics operations across industries such as manufacturing and distribution. These platforms perform a variety of tasks throughout the logistics process—from the supply of raw materials to the delivery of finished goods to end consumers. Typically powered by electric motors, these robots employ braking systems that include regenerative braking for deceleration and electromagnetic brakes for position holding.

Electromagnetic brakes are generally classified into two types: **power-on brakes**, which generate braking force when current is applied to the coil, and **power-off brakes**, which remain inactive under normal current flow but generate braking force through a spring mechanism during power interruptions. To ensure safety in the event of component failure, power-off electromagnetic brakes are predominantly used in most systems. While these brakes are primarily intended for holding position, in logistics robots they also serve as auxiliary braking mechanisms in emergency situations.

Despite their critical role, research on the technical stability and reliability of electromagnetic brakes for high-load logistics robots—particularly those with payload capacities exceeding 2 tons—has been limited. This study aims to develop electromagnetic brakes suitable for high-load logistics robots with payload capacities over 2 tons.

**[Research Content and Conclusion]**

Electromagnetic brakes for high-load logistics robots are primarily used for holding rather than dynamic braking and therefore require a specific level of **holding torque**. In this study, the target holding torque was set at 90 Nm.

The research was conducted in the following stages:

1. **Benchmarking and Initial Design**
   The braking mechanism was first analyzed by benchmarking existing commercial products, followed by preliminary design of individual components.
2. **Optimization for Target Torque**
   Based on the prototype design, an optimization process was conducted to meet the required holding torque. Using electromagnetic analysis through the commercial software **ANSYS Maxwell 2D**, the magnetic flux density was analyzed with respect to the component geometry. From this, the optimal shape satisfying the required performance was derived.
3. **Vibration Instability Analysis**
   A vibration instability analysis of the electromagnetic brake module was performed using the commercial software **Abaqus**. Complex eigenvalue analysis was carried out to identify unstable frequencies and their corresponding modes. The results confirmed the occurrence of **mode coupling** between the out-of-plane modes of the friction plate.

In future work, a prototype will be manufactured, and electromagnetic force measurements and modal tests will be conducted to verify the performance and vibration stability of the final design.