Preliminary design and vibration characteristics of an electronic brake with payload up to 2 tons

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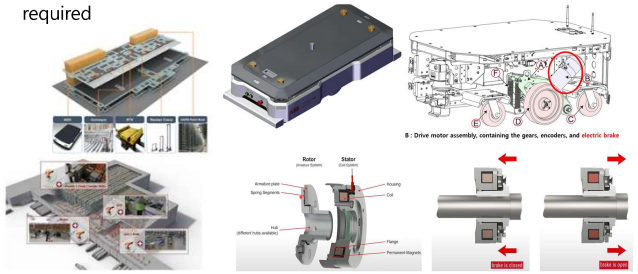
BACKGROUND

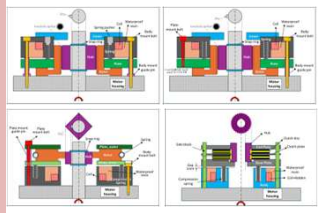
- **Large Mobile Robot Platform**
  - Smart Logistics Solution: Application of core equipment such as AGV (Automated Guided Vehicles), RTV (Robotic Transfer Vehicle), LGV (Laser Guided Vehicles)
  - In addition to building platforms using small mobile robots, we are also building platforms using large mobile robots -> **Payload of 2 tons or more**
- **Large AMR drive unit motor and electromagnetic brake integrated system**
  - Electromagnetic brakes are mounted on the motor, miniaturization and stability are required
  - High-power motors and improved electromagnetic brake output density are required



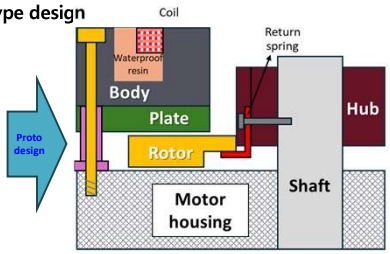
◎ **Research objective: Design and vibration instability analysis for development of electromagnetic brake for large mobile robot platform**

METHODS

- **Benchmarking analysis & prototype design**



- Constant drag occurs
  → Rotor heat generation and (partial) wear problems are expected to occur

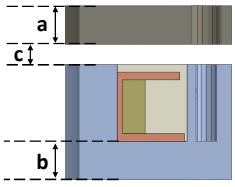


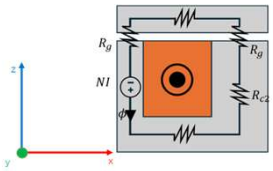
- Prototype Design
  → Zero drag mechanism

- **Analysis method**

1. **Electromagnetic field analysis (Magnetic force analysis)**

<Magnetic equivalent circuit>

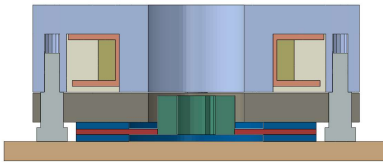


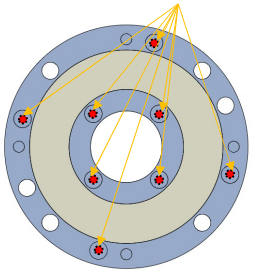


a (mm)	b (mm)	c (mm)	Current (A)
5~15	8~15	0~0.5	2

2. **Vibration instability analysis**
   - Method: Complex eigenvalue analysis
   - Friction coefficient: 0~0.5
   - Force: 2,938.68 N (8 compression springs)

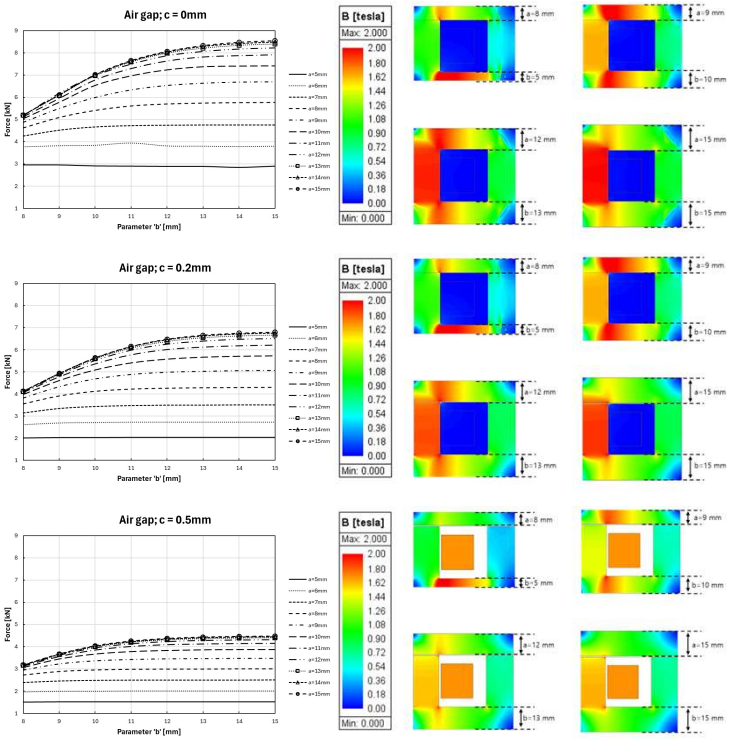
8 Compression spring location



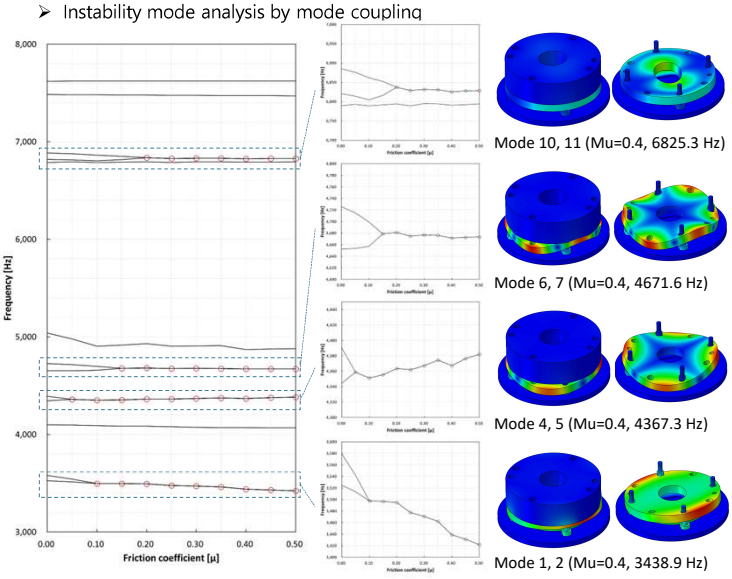


RESULTS/DISCUSSION

- **Result_1 ; Electromagnetic field analysis**
  - Analysis of electromagnetic force changes according to air gap



- **Result_2 ; Vibration instability analysis**
  - Instability mode analysis by mode coupling



CONCLUSIONS

- A prototype design was developed through benchmarking of advanced electronic brake systems, with an independently developed zero-drag mechanism.
- An optimal design was derived through a parameter study on the friction plate's actuation distance (air gap) and the electromagnetic force required to release the brake.
- Vibrational stability of the electronic brake module was analyzed using complex eigenvalue analysis, which confirmed that all unstable vibration modes primarily stem from mode coupling between out-of-plane modes generated in the friction plate.
- A prototype will be fabricated in the future to measure electromagnetic force and perform a modal test, thereby verifying the suitability and vibrational stability of the designed system.

NAPLES, ITALY 30 JUNE - 4 JULY
ACEX2025 NAPLES
18th International Conference on Advanced Computational Engineering and Experimenting

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