

Introduction

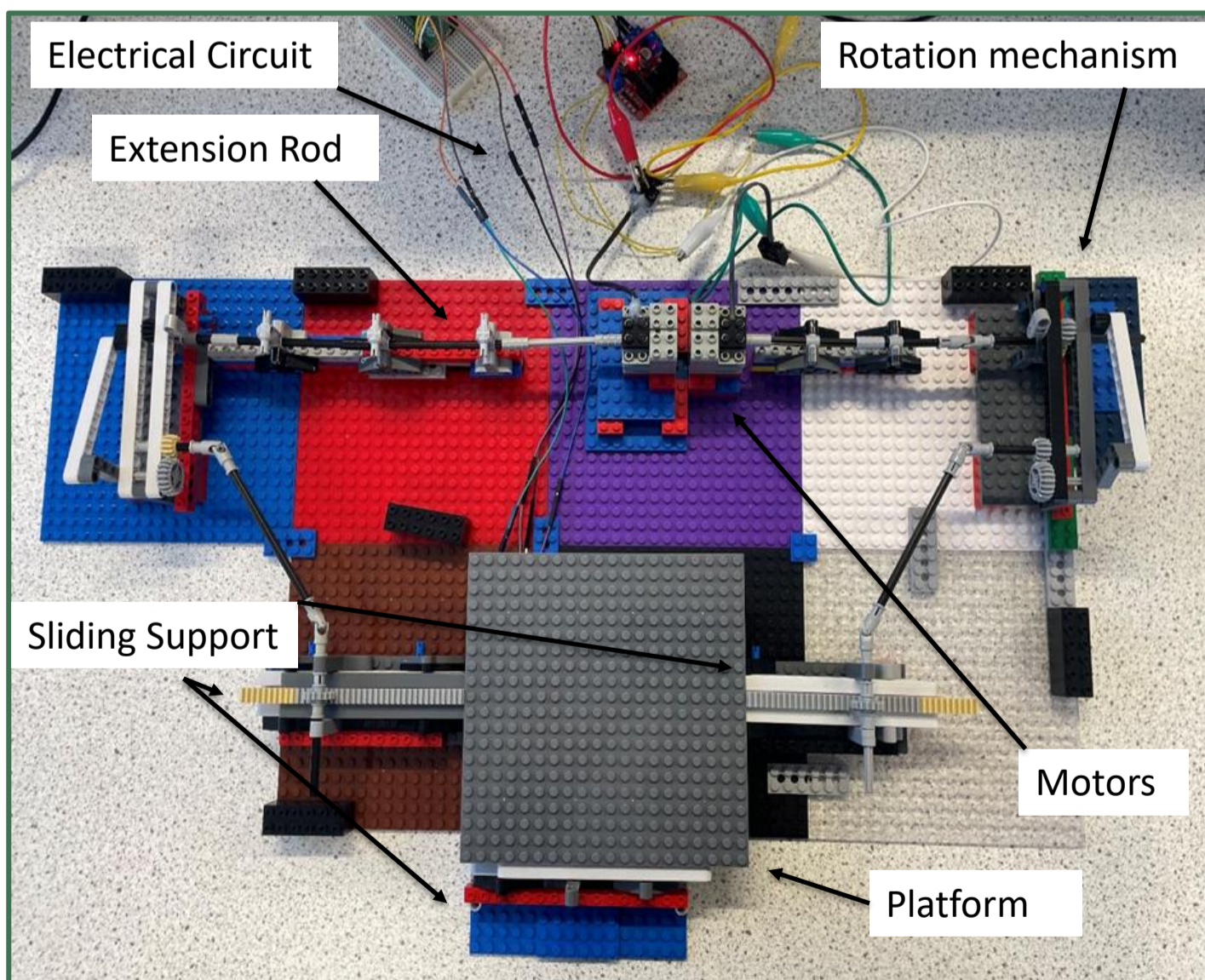
- Traditional earthquake shaking tables are expensive, complex, and inaccessible for many institutions.
- This project investigates whether a low-cost, programmable LEGO-based shaking table can be used to simulate real seismic activity using real-world earthquake data, offering a modular alternative to traditional structural testing platforms.

Research Questions:

1. What is the scientific significance of developing an earthquake-shaking table using LEGO?
2. How can real seismic effects be replicated with LEGO motor blocks, using previous earthquake seismic data as a reference for ground acceleration?

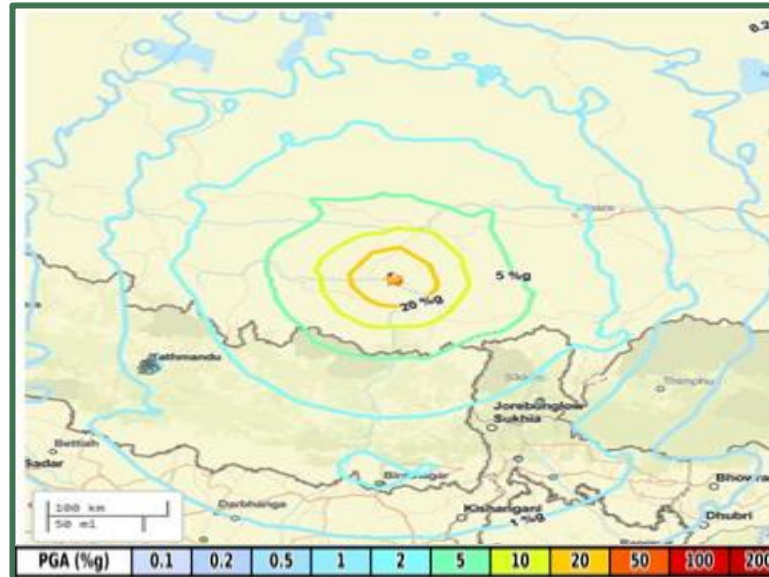
Methodology

- The functionality of the shaking table only took into consideration the horizontal motion experienced during earthquakes.
- For the movement of the shaking table, a variable power supply was used to power two DC LEGO motors with indirect translation from the Raspberry Pi Pico with the use of the motor driver L298N Dual H-Bridge, with the MPU-9250/6050 Breakout connected for its accelerometer function.
- The data for real-world earthquakes was retrieved from the USGS website and converted to suitable files for Thonny using custom Python scripts. Seven earthquakes were taken, ranging from various locations and magnitudes (7.6M to 5.5M).
- The tests of the earthquake had three loading conditions for the MPU-9250 Breakout:
 - No Load (raw ground motion response)
 - Tower Load (simulated an estimated proportional building structure)
 - iPhone Load (a heavy compact mass)
- The use of a secondary smartphone app accelerometer (Sensor Logger) was used simultaneously with the iPhone Load to validate the results from the MPU-9250 Breakout.



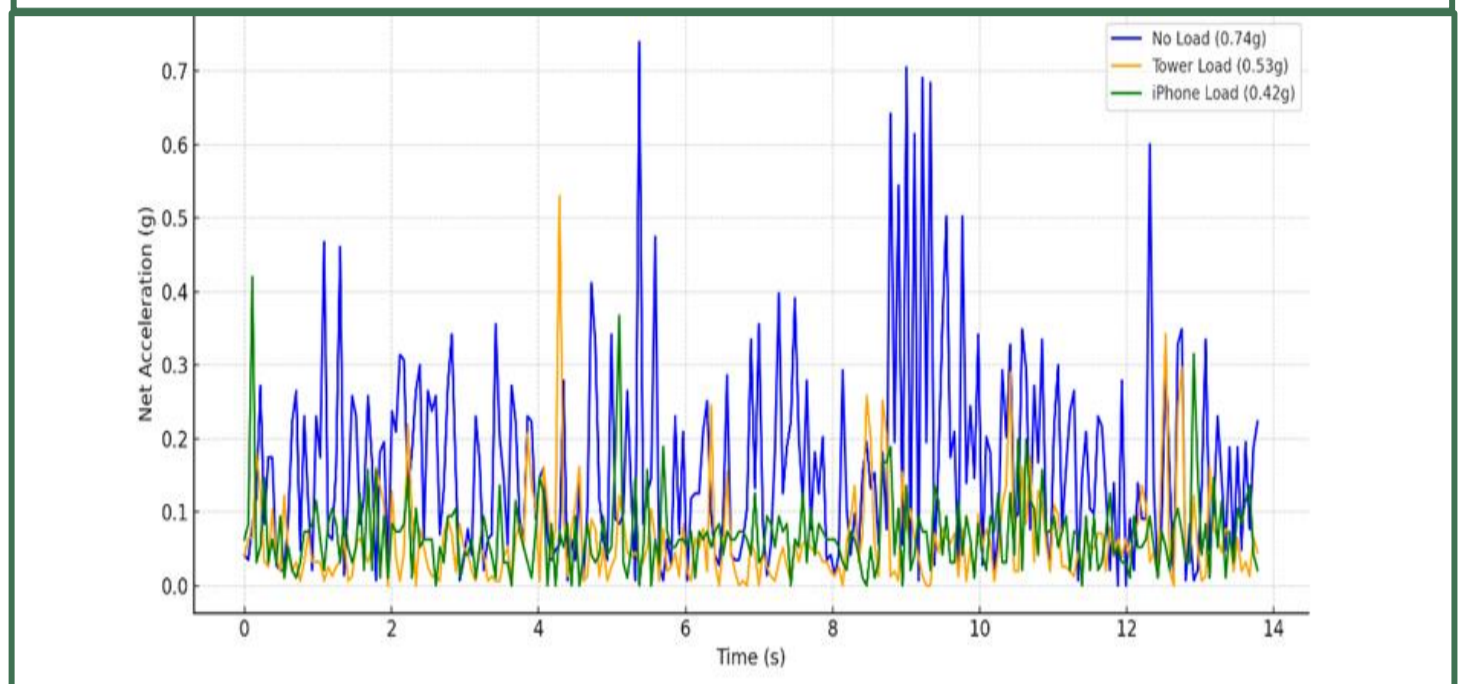
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Results

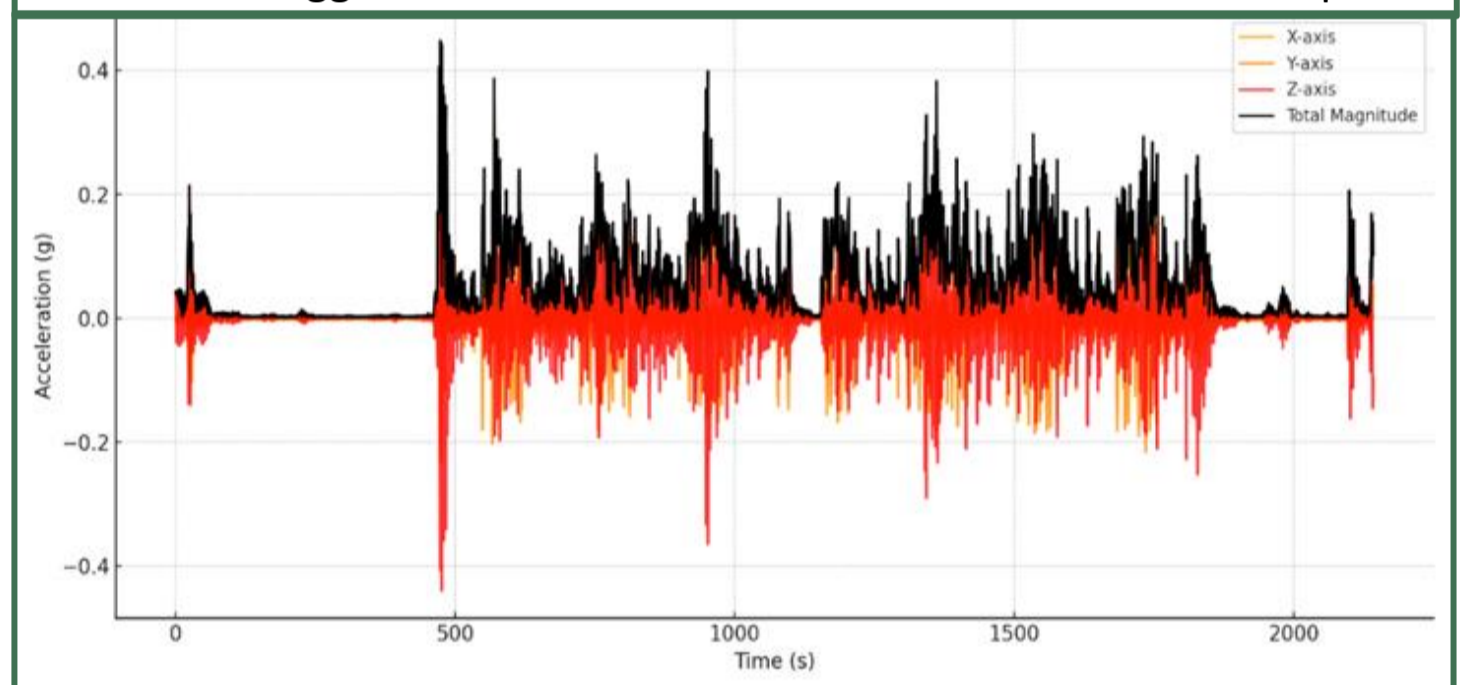


Measurement Source	PGA (g)
ShakeMap Estimate	0.5
Sensor Logger	0.44
MPU-9250 (No Load)	0.74
MPU-9250 (Tower Load)	0.53
MPU-9250 (iPhone Load)	0.42

Three Load Condition MPU-9250 Breakout Results for the Southern Tibetan Plateau Earthquake.



The Sensor Logger Results for the Southern Tibetan Plateau Earthquake.



- Results were calculated in PGA (Peak Ground Acceleration).
- The No Load condition had the highest PGA values, while the iPhone Load had the lowest PGA values (negative correlation).
- Earthquakes with higher magnitudes produced higher PGA readings (positive correlation).

Conclusion

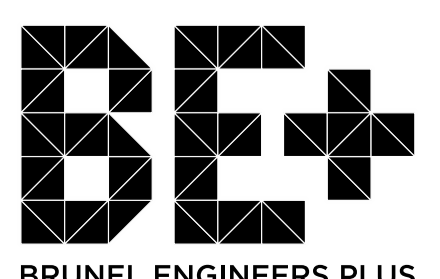
- The shaking table was able to successfully replicate real-world earthquakes in terms of peak ground accelerations.
- The use of another accelerometer in the Sensor Logger helped to validate the iPhone Load results further.
- There were many limitations and opportunities to further develop the shaking table, such as:
 - Using more fluid mechanisms
 - Further development in the electrical and software assembly
 - Added consideration for vertical motion
- This project has opened the door to using LEGO-based solutions to solve modern construction challenges.
- LEGO is a sustainable material: durable, reusable, and recyclable.

References

USGS.Gov. (2025). Significant Earthquakes - 2025. [online] Available at: <https://earthquake.usgs.gov/earthquakes/browse/significant.php>

Project Title: Constructing Tomorrow: Exploring LEGO-Based Solutions for Modern Construction Challenges

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