KANSAI INTERNATIONAL AIRPORT
The goal is to find the location of a third runway that minimizes the energy and power of the waves on the terminal building to further protect it from hazards.
The objective of this project is to provide an assessment of the placement of an additional runway built for the Kansai International Airport. This will be done by creating a simplified model of the three runway system and analyzing the different energy and power measured at a point on the terminal building island. The focus of our project will be to find the design that reduces the wave energy and power for the terminal building because this is ultimately the most important of the three buildings.
Artificial Islands:

- Built approximately 5 km offshore of Japan and a depth of 18 m
- The terminal building is approximately 3.5 km by 1 km built in 1994
- In 2007, an additional runway was built measuring approximately 4 km by 1 km
- There is currently a plan to build a third runway measuring approximately 3.5 km by 1 km.

Reasons for building offshore:

- Limited land space
- Reduce noise pollution
Estimates on sinking ranged from 19ft to 25ft.

Built as if it would only sink 19 ft

Kansai sunk 27 ft by 1990 and continues to sink today. To solve this problem, more soil needed to be added.

The airport was specifically designed to deal with this foreseen sinking and has adjustable doors and support beams that used hydraulic jacks to keep the building even.
Japan is an extremely high risk hazard area prone to strong earthquakes, tsunamis, and typhoons. The building joints in the airport were specifically designed to be flexible enough not to break during earthquakes.
Since the island is very close to sea level, large waves are its biggest threat. To deal with this, a seawall was built to withstand a 50 year surge. Then later, this was added to even more so that the total seawall height reaches 12 m tall.
In 1995, 4 months after KIA opened, a 7.2 magnitude earthquake occurred just 20 km away.

The airport came out almost completely unscathed.
METHODS

- Physical model
- Flow pattern observation
- Wave energy calculation
DIFFERENT SET-UPS

Set-up 1

Original runway
Original airport
New runway

Set-up 2

Original runway
New runway
Original airport

Original runway
Original airport

Land
DIFFERENT SET-UPS

Set-up 3

Set-up 4

Set-up 5

Set-up 6
FIRST TRIAL: INITIAL IDEA

- Clay model, scaled
- Measure wave height at three location
- Calculate wave energy
FIRST TRIAL: ACTUAL TEST

- Clay fell apart in water
- Stability issue of our model
- Inconsistent hand made waves
- Failed in measuring wave height
  - Extremely small and inconsistent changes of water level
  - Hard to read the ruler in water
SECOND TRIAL: MODIFIED IDEA

- Focus on the observation of wave flow pattern
- The effects of diffraction at the area close to the airport structure
- Plastic lunch box filled with sand to and brick model
SECOND TRIAL: ACTUAL TEST

- Bricks model
- Inconsistent hand made waves
- Diffraction was observed
- Space and lighting condition limitation affects video quality
In set up 2, 4, 5, water was more calm at the area near the airport structure.
THIRD TRIAL: FURTHER MODIFIED IDEA

- Brick model
- Measure wave amplitude
THIRD TRIAL: ACTUAL TEST

- **Consistent wave generated by wave maker**
- **Measured:**
  - Wave length
  - Water depth
  - Frequency
  - Wave height at the side wall of the airport brick
- **Quantitative analysis**
# RESULTS

- Wave length
  - Measurement (4.8cm) vs. calculation (8.2 cm)
- From wave height to wave energy

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<th>Arrangement</th>
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Comparison of Wave Energy Reduction in Different Set-ups (%)

Set-up 2 achieved the greatest energy reduction in the area near the airport structure.
The best formation to use to mitigate the wave power and energy on the terminal building is Set-Up #2
KANSAI’S DESIGN

- Artist representation:
Set up #6 is very similar to the final design of the airport
- Set-up #6 is tied for the second lowest power and energy values
- This set up was most likely chosen for two main reasons:
  - Cheaper to add on to an island than make an entirely new one.
  - May strengthen the airport more as a whole instead of focusing on protecting the terminal building.
REFERENCES


