Natural hazard experiences and countermeasures in Japanese railways

East Japan Railway Company (JR East)
Natural hazards experienced by Japanese railways

JR East’s countermeasures against Natural hazards
About JR East

- Established in 1987
- 7,512km network
- 1,689 stations
- 70 lines
- 17 million passengers/day
- 13,000 trains/day
Natural hazards for railways

1. **Rain**: Landslide, Flooding, Scouring

2. **Wind**: Derailment, Flying Obstacles, Fallen leaves

3. **Waves**: Shoreline erosion

4. **Snow**: Fallen trees, Avalanche

5. **Others**: Heat wave, High or low temperature, Thunder, Fog, Earthquake…
Hazard of Rain

- Heavy rain (427mm for 2 days)
- Landslide, Flooding
- Niigata (JR East)
- 12-13 July 2004
Hazard of Rain 2

- Tokyo (Tokyo Metro)
- 4 October 2004
- Typhoon and heavy rain (400mm in 3 days)
- Rain water flooded a subway station
Hazard of Rain  3

■ Long rain (500mm in 2 months)
■ Rise of the groundwater level
■ Floating of the structure of semi-underground station
■ Tokyo (JR East)
■ 11 October 1991
Hazard of Rain 4

- Strong typhoon
- Scouring, pier collapsed, two spans washed away
- Single-track operation on parallel bridge for 75 days
- Shizuoka (Japanese National Railways)
- 2 August 1982

Source: Yomiuri New Paper

Source: Fuji City
Hazard of Wind  1

- Strong wind (over 30 m/s)
- Derailment, train falling from the bridge
- 6 fatalities: 5 general public and the train conductor
- Hyogo (Japanese National Railways)
- 28 December 1986
Hazard of Wind 2

- Tornado or Downburst
- Derailment
- 5 passengers killed, 32 passengers seriously injured
- Yamagata (JR East)
- 25 December 2005
Hazard of Waves

- High waves, Coastal erosion
- Collapse of shore protection wall
- Yamagata (JR East)
- 19 December 2000
Hazard of Snow

- Half of the main island is in the snowbelt
- Snow damage occurs often in Japan
- Fallen trees, Avalanche
1/3 of traffic disruptions in JR East are caused by natural hazards.

- Natural hazard: 442
- Internal factor (Failure of vehicles, etc): 381
- External factor (Accident at crossing, etc): 532

Data FY2010
Natural hazards experienced by Japanese Railways

JR East’s countermeasures against Natural hazards
Countermeasures by JR East

1. Greater resilience of network
2. Installation of monitoring system
3. Education and training
4. Research and development
Greater resilience of network: rain

- Slope reinforcement
- Scouring protection
Greater resilience of network: wind

- Windbreak fence/screen
- Windbreak forest
Greater resilience of network: snow

- Anti-avalanche facilities
- Snow removal equipment
- Anti-snow measures on trains
- Snow protection forests

Snow removal equipment

Sprinkler

Snow blower (Air jet)
Installation of monitoring system

Monitoring and restrictions

- Speed restrictions
- Traffic suspension

- Anemometer
- Snow gauge
- Rail temp. gauge
- Scouring detector
- Seismograph
- Rain gauge
- Water gauge
- Landslide detector

Installation of monitoring system
- Network

March 2010

<table>
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<tr>
<th></th>
<th>High-speed line</th>
<th>Conventional line</th>
<th>Total (per 100km)</th>
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<tbody>
<tr>
<td>Rain gauges</td>
<td>29</td>
<td>537</td>
<td>566 (7.5)</td>
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<tr>
<td>Water gauges</td>
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<td>592</td>
<td>592 (7.9)</td>
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<td>Anemometers</td>
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<td>Seismographs</td>
<td>97</td>
<td>196</td>
<td>293 (3.9)</td>
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Education and training

Training center

Training at depot

The Accident History Exhibition Hall
Research and development

The Disaster Prevention Research Laboratory

- Study on mechanism of natural disasters and risk evaluation
- Development of observation and detection methods
- Development of countermeasures and technical standards

Simulation

Hazard map
Capital investment of JR East

- Half of JR East’s investment is for safety.
- In 2010, 20% of the safety investment is for the countermeasures against natural hazards, which is equivalent to about 40K euro/km.
- Total annual investment is within the limits of cash flow.
# Governmental funding for railway

<table>
<thead>
<tr>
<th>Subject</th>
<th>Euro (million)</th>
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<tr>
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<td>Urban lines</td>
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<td>Technology development</td>
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<tr>
<td>Safety prevention</td>
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<td>Natural disaster prevention</td>
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<td>Others</td>
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One of the most important missions of a railway company is to run trains safely. However, it is impossible to predict natural hazards accurately. Therefore, we have been taking practical measures by learning from past experiences.
Thank you for your attention