

International Institute of Seismology and Earthquake Engineering



## Strong Motion Observation of BRI

### **Toshihide Kashima**





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### Outline

- Nationwide strong motion network for buildings started in 1957
- 74 stations with digital instruments in operation
- Aims to contribute to the improvement of seismic design technology for buildings
- Targets effect of surface geology, input earthquake motions to buildings and dynamic behavior of buildings during earthquakes



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### Site location





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### **Recent Progress**





Targets





### **Sensor Configuration**





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### **Typical Sensor Configuration**





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### Example











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# Effect of Surface Geology (Sendai #1)

### Acceleration at hard and soft sites





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# Effect of Surface Geology (Sendai #2)

Fourier spectra at hard and soft sites





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### BRI Annex Outline

11 sensors in the annex building

- 4 in the main building
- 7 in the surrounding ground





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### BRI Annex Sensor configuration in section





### BRI Annex Sensor configuration in plan





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### **BRI** Annex

Change of dynamic characteristics

- f<sub>0</sub> is falling with time
- f<sub>0</sub> show amplitudedependence
- $h_0$  is 2% to
- 3%





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### Kushiro Government Office Bldg. Outline

### 9-story SRC building with steel braces





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### Kushiro Government Office Bldg. Base isolation devices

- 64 Laminated rubber bearing
- 56 Lead Damper
- 32 Steel Damper







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### Kushiro Government Office Bldg. Sensor configuration

## 3 sensors in the ground and 3 sensors in the building





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Origin time	2003/09/26 04:50
JMA Magnitude	8.0
Focal Depth	42 km
Casualties	2 Missing,
	>700 Injured
Damaged	12 Collapsed,
Houses	>500 Partially Destroyed



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### NMWA Outline of building

 National Museum of Western Art (NMWA), Ueno park, Tokyo
RC/3F+B1F, Historic building (designed by Le Corbusier)





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### NMWA Retrofitting work

- Seismic retrofitting in 1998 with preserving exterior
- Base isolation system with 49 highdamping rubber bearings





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NMWA Sensor configuration

### GL, 2 sensors at B1F, 2 sensors at 1F and RF (6 in total)





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### NMWA Strong motion records

101 strong motion data (2000-2008)
PGA: 0.942 m/s<sup>2</sup> (Feb. 16, 2005)





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### NMWA Acceleration records

## M5.4, *h*=45 km, February 16, 2005 Distance: 37 km, PGA: 0.942 m/s<sup>2</sup>





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### NMWA Fourier spectral ratios (Feb. 16, 2005) Input loss and base isolation









1F/BF





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### NMWA Fourier spectral ratios (Feb. 16, 2005) Building and overall















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### NMWA Fourier spectral ratios (Feb. 16, 2005)

### Torsional movement







1FE/1FW



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### NMWA Natural frequency and damping ratio

 Assume SDOF
Identify *f* and *h* from input and resp.









### NMWA Conclusions

- More than 100 records have been acquired
- Basic dynamic characteristics were discussed using a moderate record
  - Amplitude-dependency of natural frequencies was clearly observed
- Large damping effect was verified even in small amplitude range