



# Evaluation of vibration during the tunnel extension for upgrade ILC

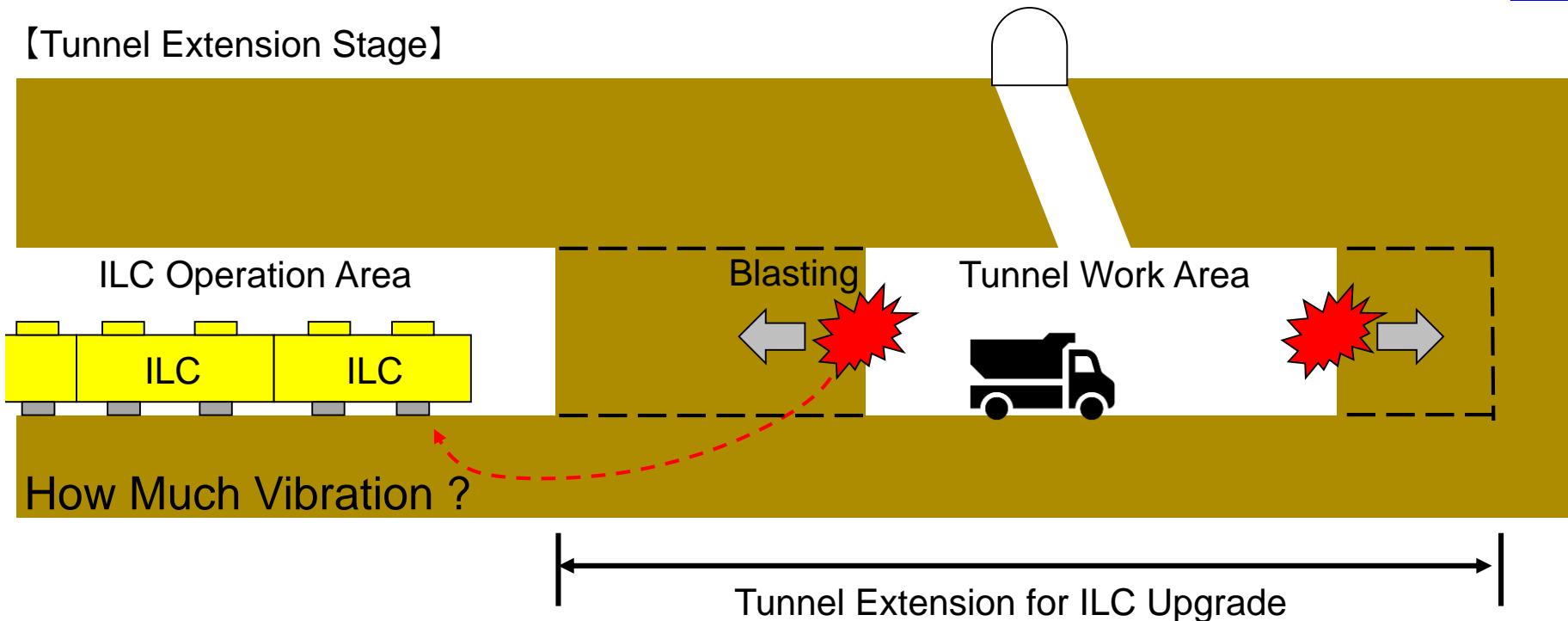
October 30, 2019

TOBISHIMA Corporation  
KIYOSHI KANEMATSU



# Introduction

【Tunnel Extension Stage】



## ■ Measure Tunnel Construction Vibration

【Targets】

- **Blasting**
- Construction Machine (mucking, trimming, shotcrete, drilling)



# Research system

## Joint research

### TOHOKU Univ.

- Dr. SANUKI (Associate professor)
- Dr. Kyoya (Professor)
- Dr. Yoshioka (Professor)

### TOBISHIMA Corp.

- TOHOKU branch offices
- Civil Engineering Division
- Research Institute of technology

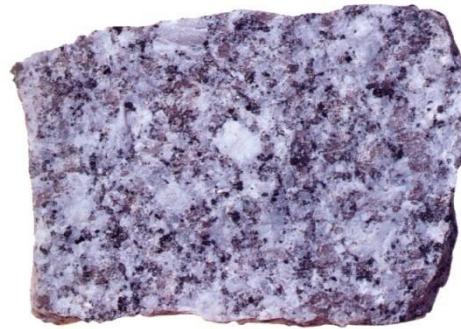
## Research cooperation

### IWATE Prefecture

Prefectural South Area Promotion Bureau,  
Science ILC promotion office



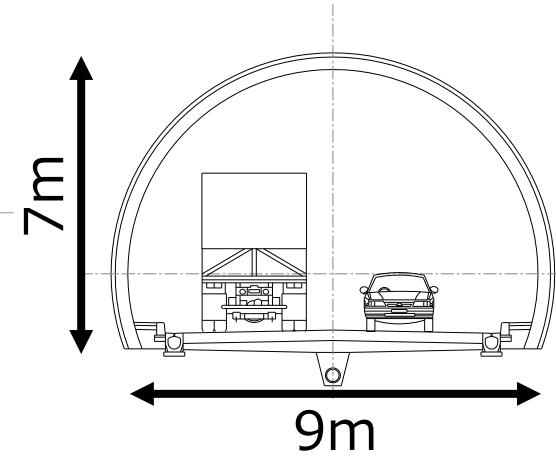
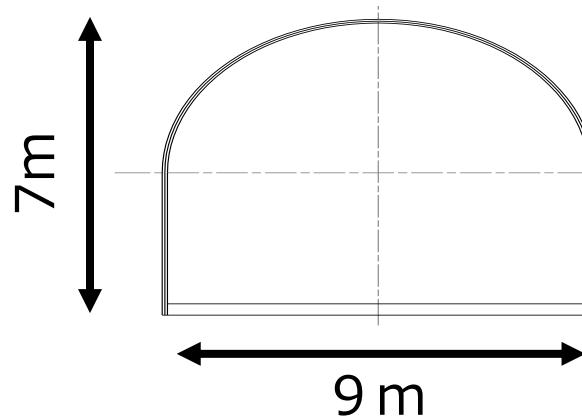
# Measurement Site



Granite

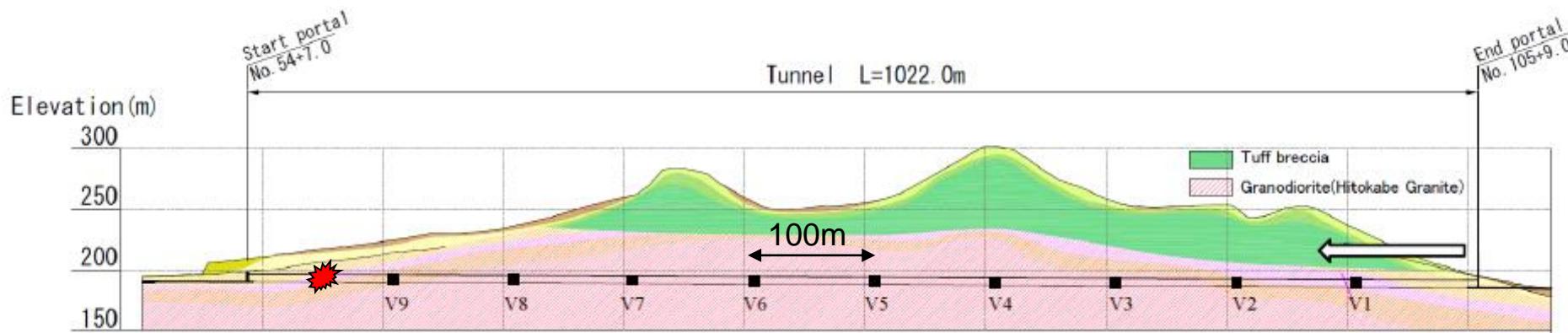
## 【Similarities】

- Bedrock : Granite
- Tunnel size : 70m<sup>2</sup>





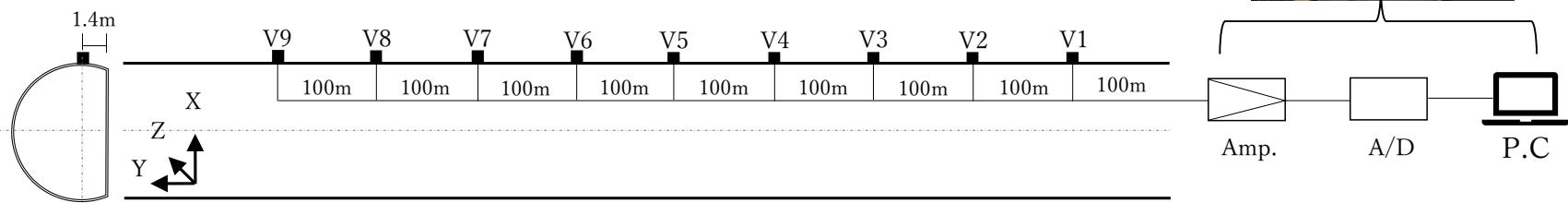
# Measurement of blasting vibration



Tunnel profile and vibration measurement position



Vibration sensor



Measurement system

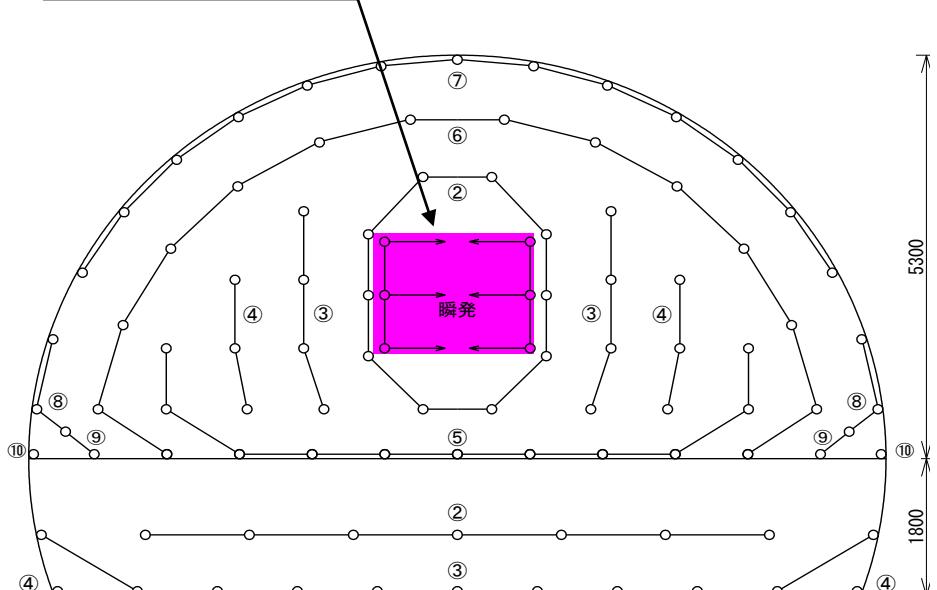


# Blast targeted for investigation

## Specifications of the blasting surveyed

Time period	19.9.2017 ~ 2.3.2018 (260 data)
Suppot pattern	D I ( 22%), C II ( 78%)
Detonator	DS Type (10 steps)
Explosive amount (center blasting)	0.4kg~14.0kg
Explosive amount (Total)	21.6kg~137.2kg

Center Blasting



Blast pattern (example: CII)

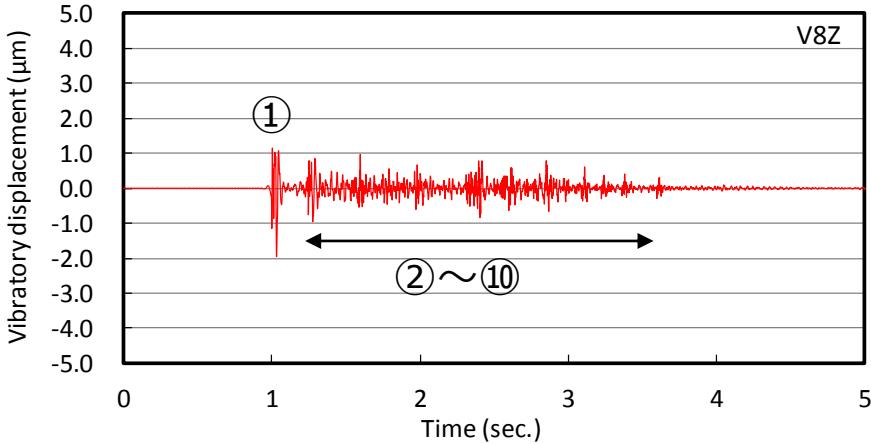
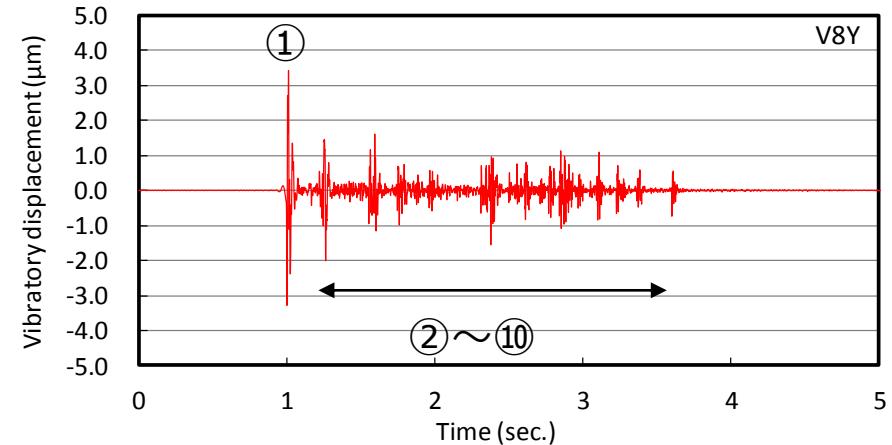
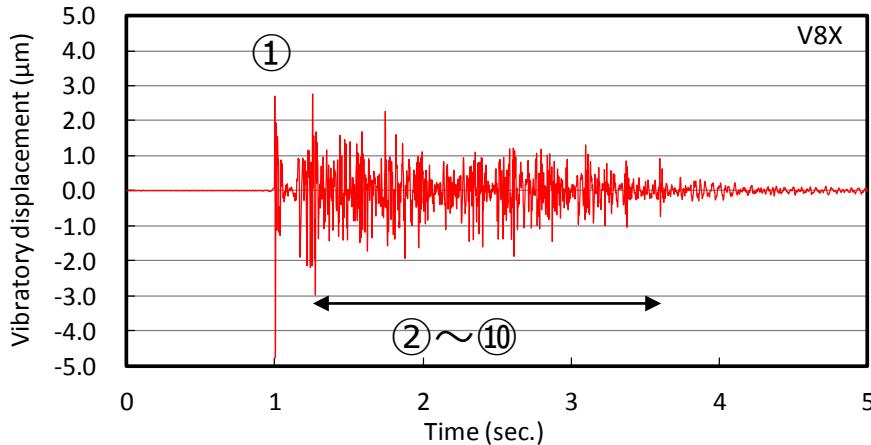


# Blasting





# Time waveform

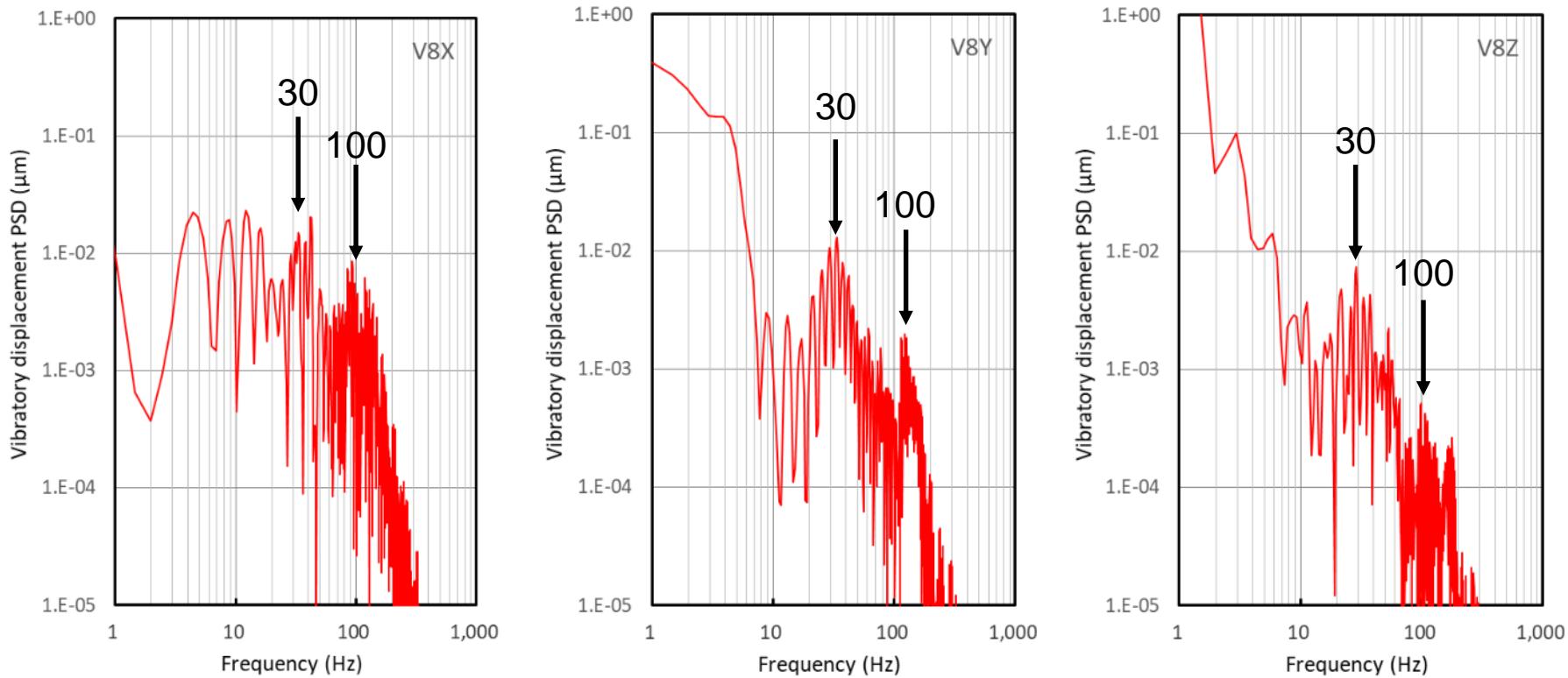


## Blast specifications

Time and date	12:24 :18, 18.1.2018
Distance	About 66m from the working face
Support pattern	C II pattern
Detonator	DS Type (10 steps)
Explosive amount	Center : 4.8kg, total : 80.8kg



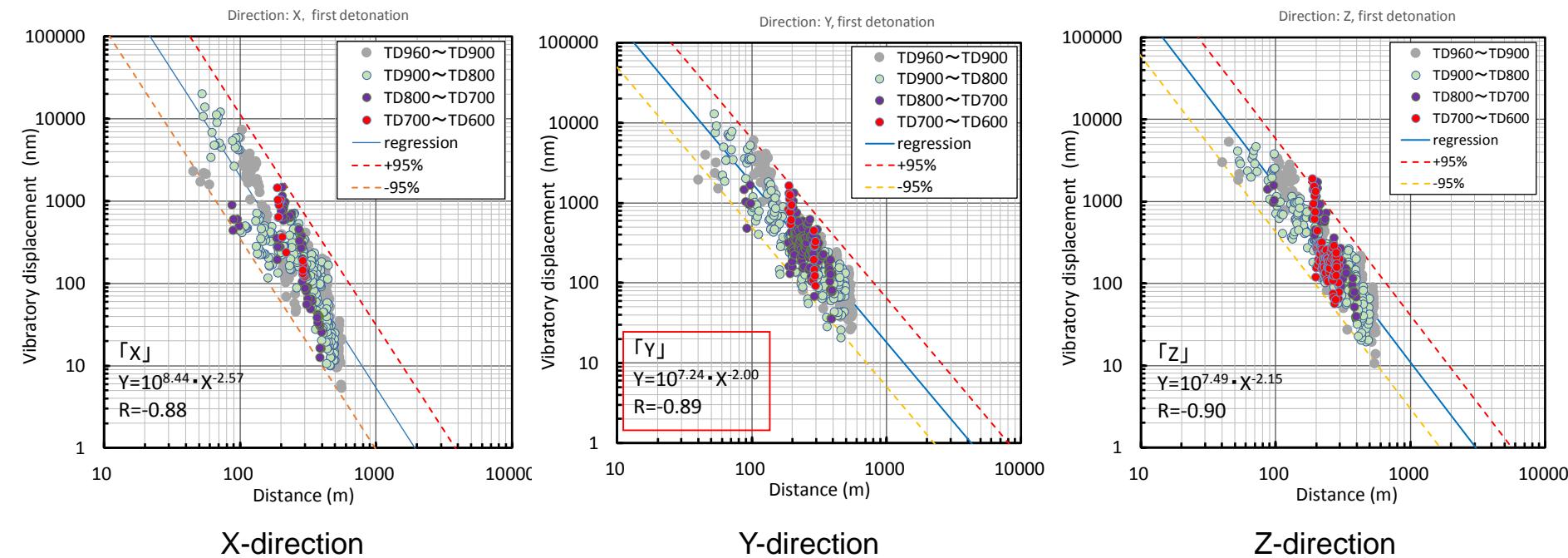
# Frequency characteristic



Sampling frequency : 1000Hz, Number of data : 2048 ( $\Delta f : 0.488\text{Hz}$ ,  $T : 2.048 \text{ sec.}$ )



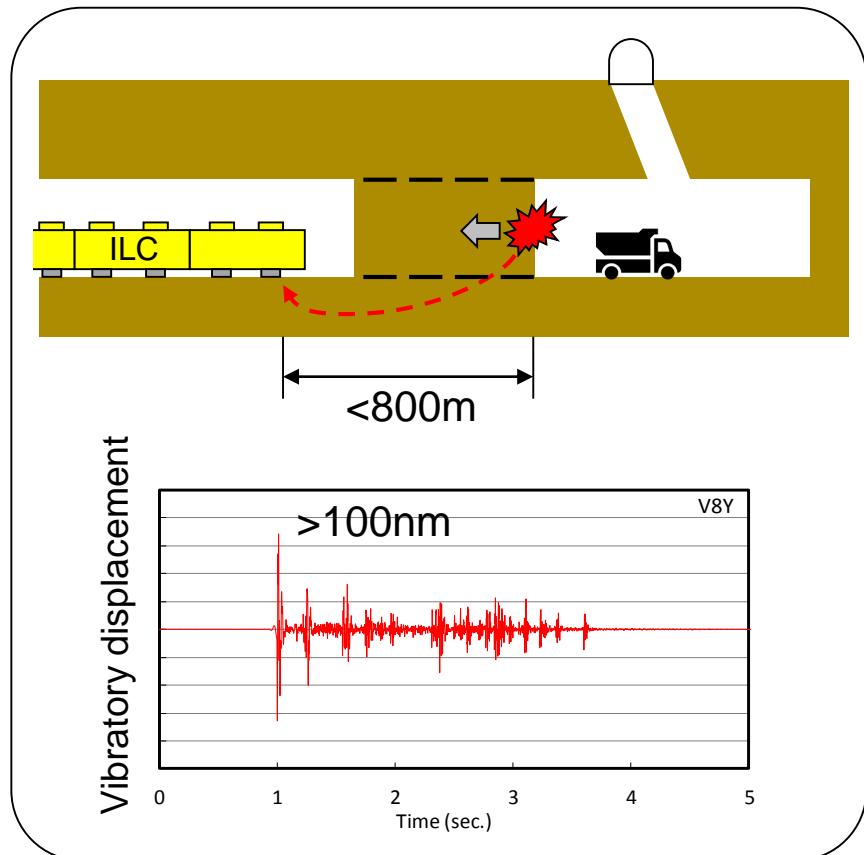
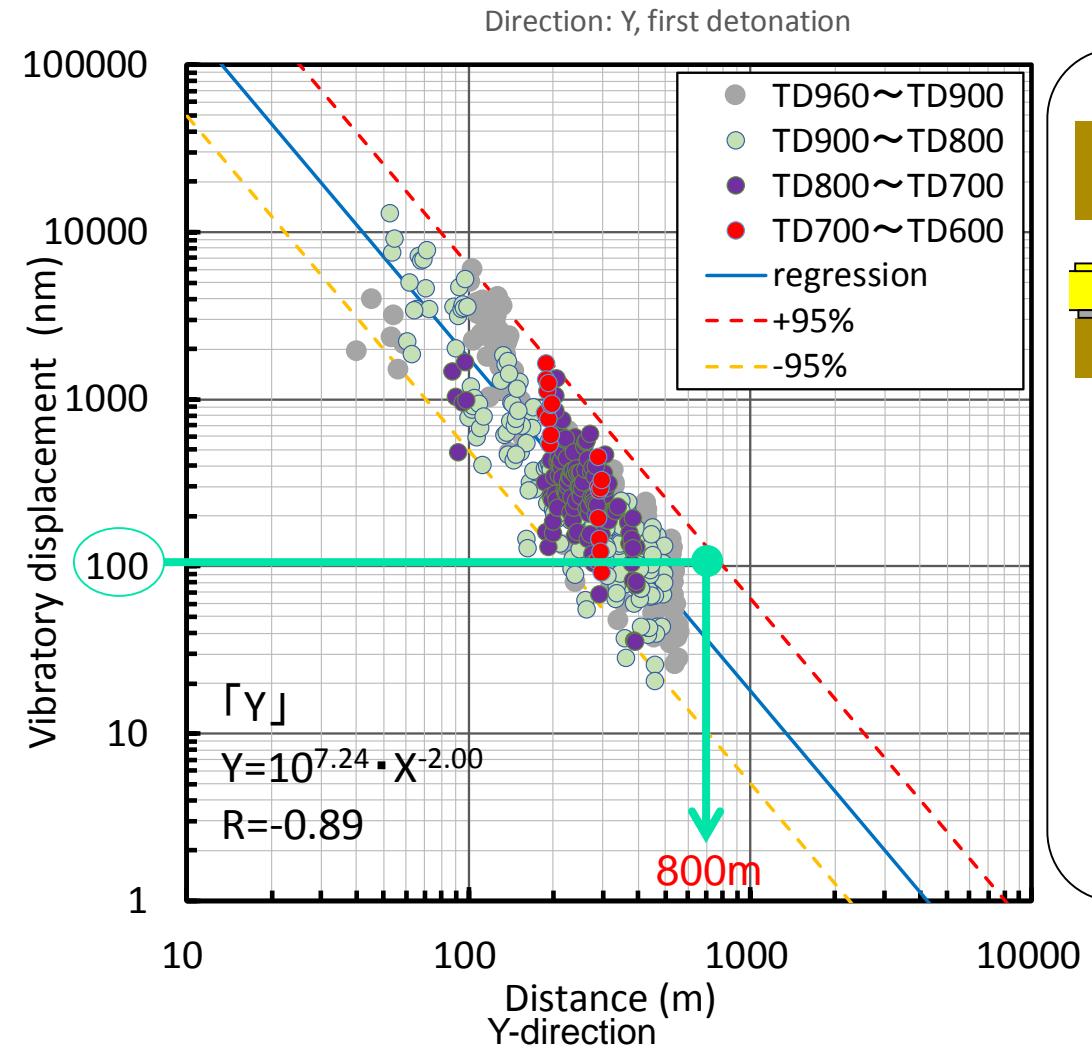
# Attenuation due to propagation distance



- ✓ Vibration displacement is inversely proportional to the square of the distance.

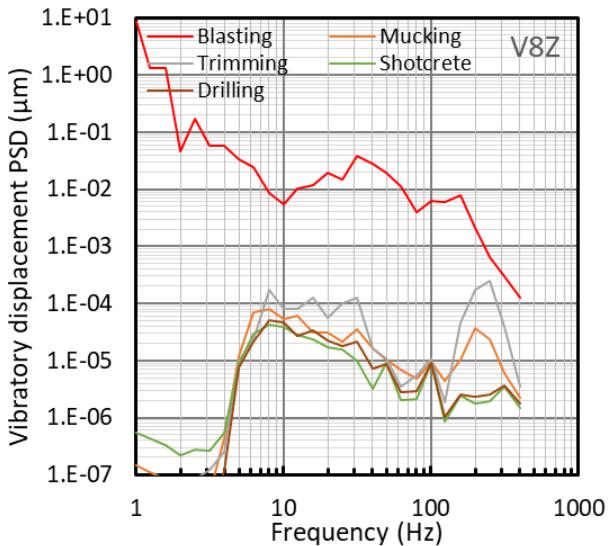
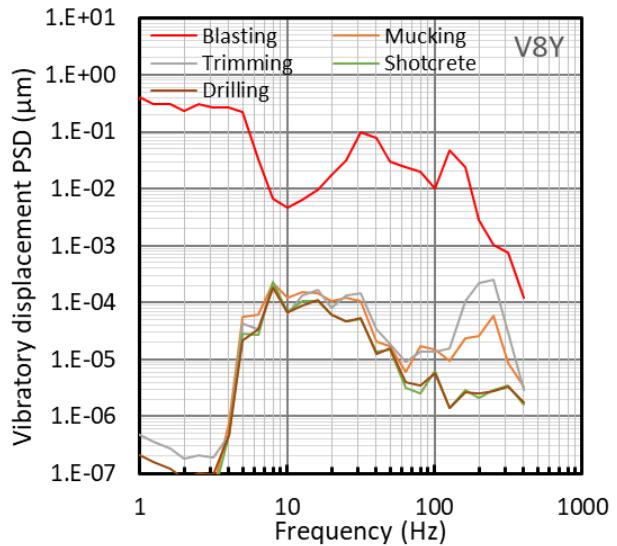
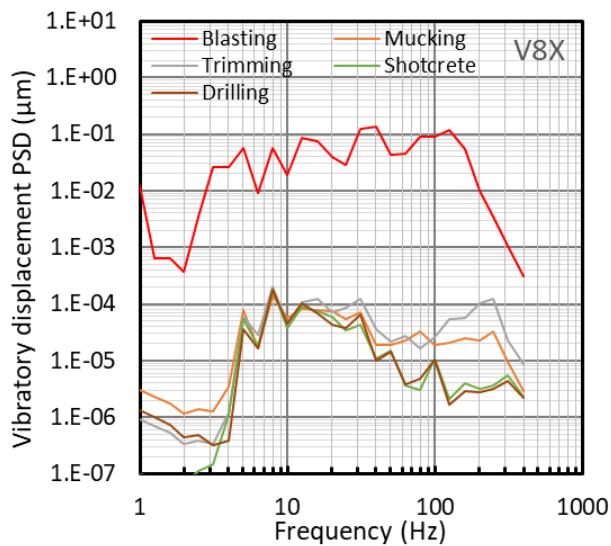


# Attenuation due to propagation distance

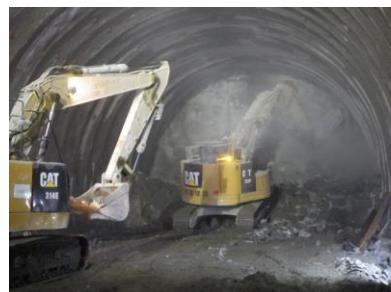




# Vibration caused by work other than blasting



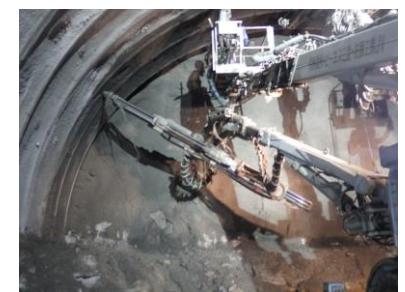
Mucking



Trimming



Shotcrete



Drilling



# Conclusion

- ✓ We measured tunnel construction vibration, mainly blasting vibration.
- ✓ We found that the displacement of the blasting vibration is inversely proportional to the square of the distance.
- ✓ We got a formula to predict the vibration displacement at a position away from the blasting position.
- ✓ Using that formula, the position where the vibration displacement is 100nm or less is at a distance of 800m or more from the blasting position.



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Thank you for listening.