Numerical verification on application of
Structure Health Monitoring
SVD to SHM for bridge structure
Singular Value Decomposition

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Demand of our society

High-standard road network
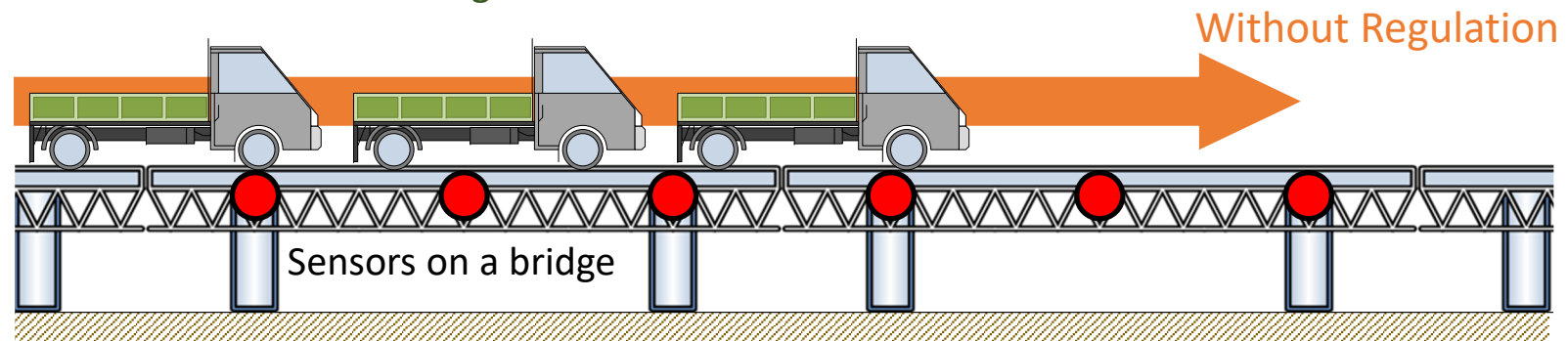

Japan

Germany
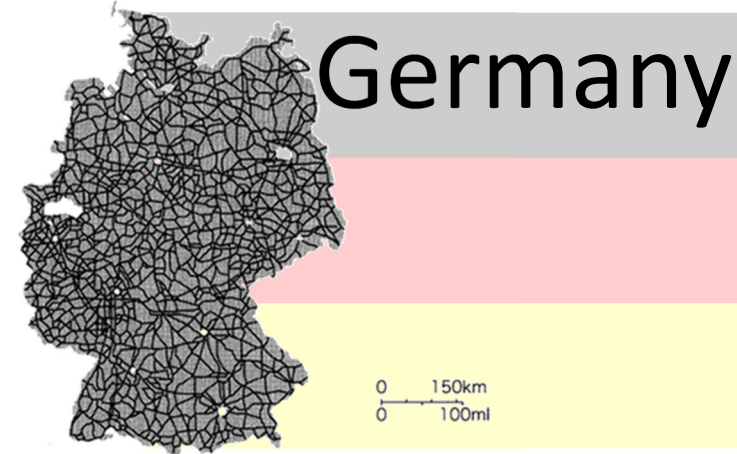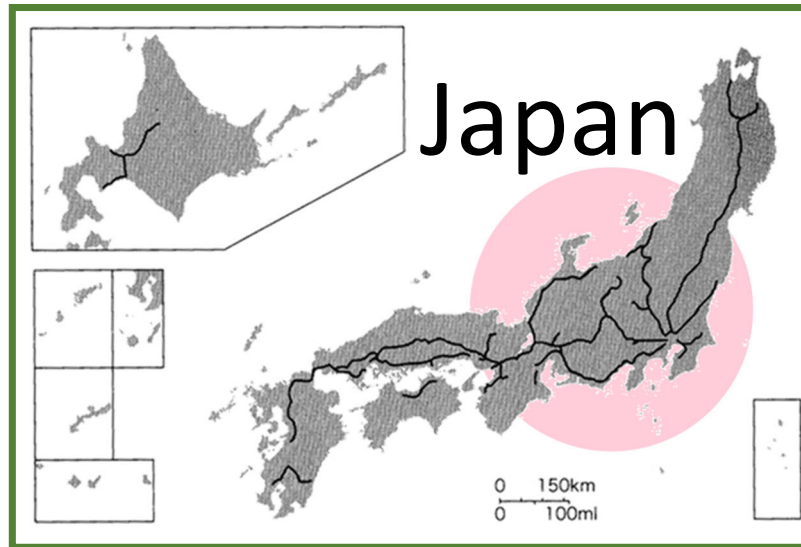
▼ **Poor Bypass**

Bridge Health Monitoring without Traffic Regulation

Objective

SHM based on **Traffic-induced Vibration**
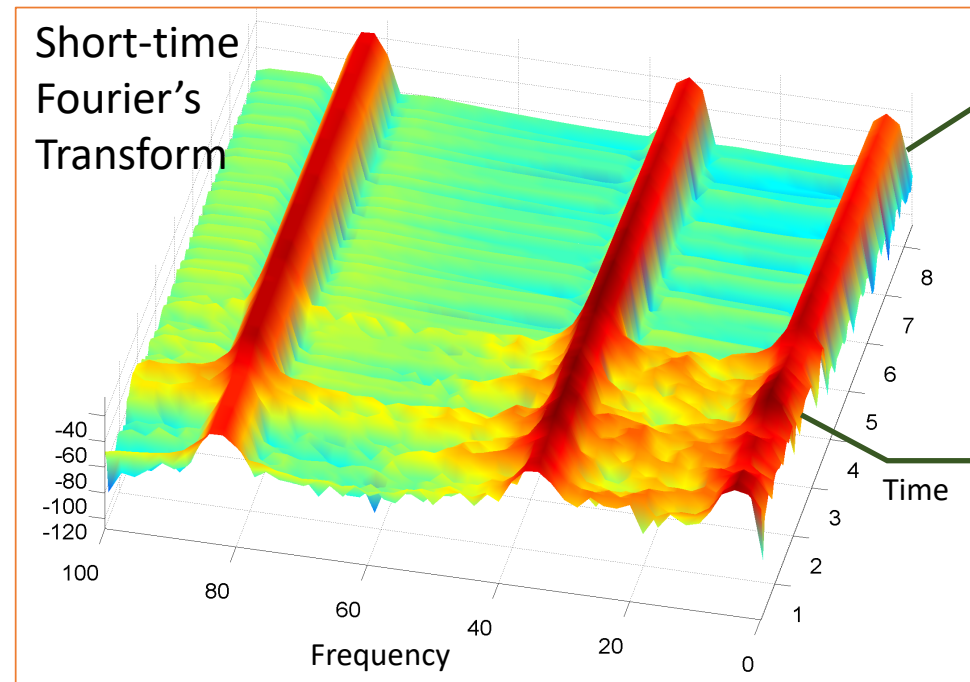Structure Health Monitoring

Without Regulation

Sensors on a bridge

Merit

Large Amplitude

easy to measure

De-merit

Forced Vibration

difficult to analyze

Traditional method

Analysis of Transient

Short-time Fourier's Transform

Free Vibration
after vehicles' passing

Forced Vibration
during vehicles' passing
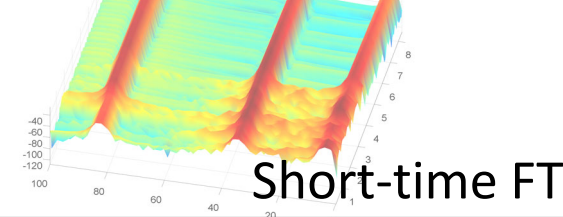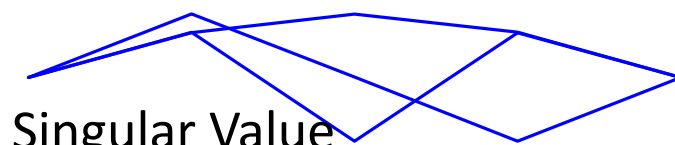**Object of this study**

New method

Analysis of Transient

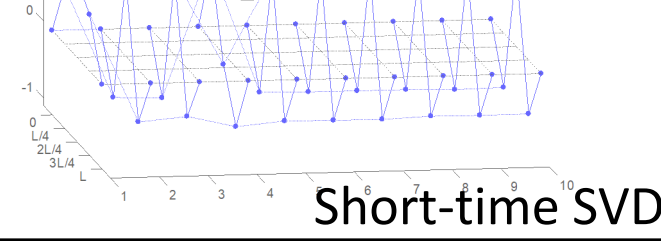**Frequency**
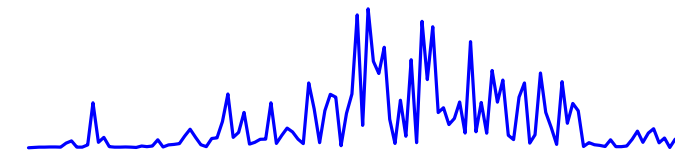
Fourier's Transform

Time-Frequency

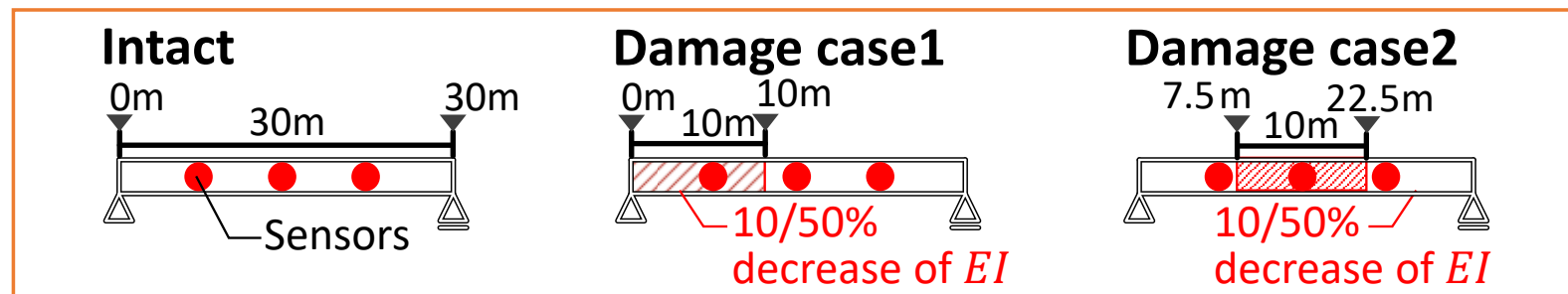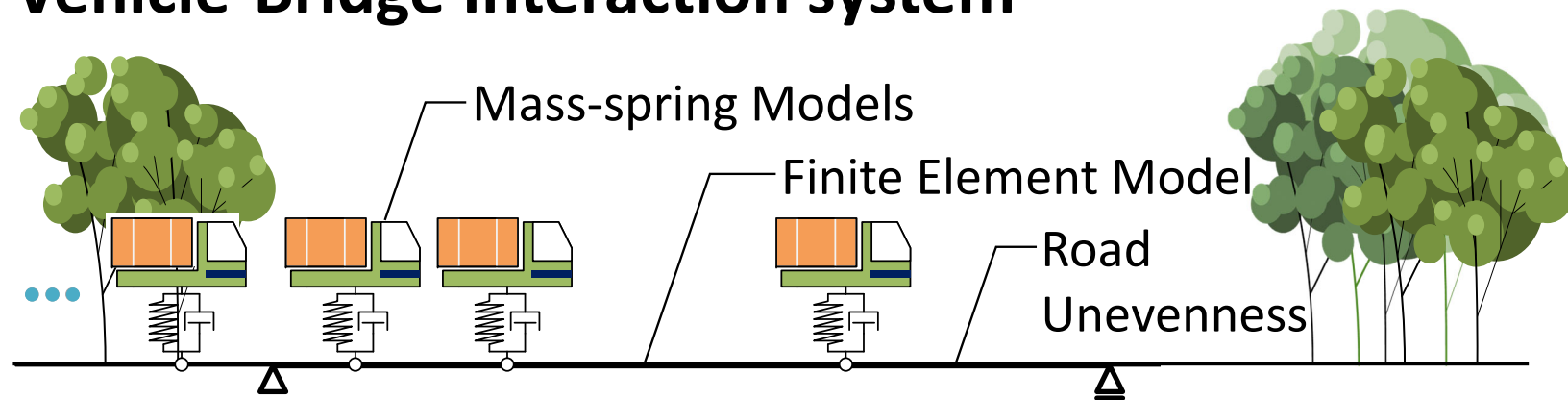Short-time FT

Spatial

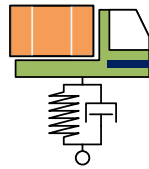Singular Value Decomposition

Time-Spatial

Short-time SVD

Numerical verification

Vehicle-Bridge Interaction system

Mass-spring Models

Finite Element Model

Road Unevenness

Intact

0m 30m
30m

Sensors

Damage case1

0m 10m
10m

10/50%
decrease of EI

Damage case2

7.5m 22.5m
10m

10/50%
decrease of EI

Model Parameters

Vehicle

Bridge

The vehicle parameters		
Number of cars		10
Mass	[ton]	5.0~7.5
Velocity	[m/s]	23~26
Eigen-frequency	[Hz]	1.1~1.5
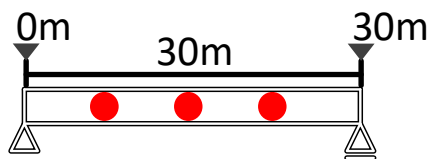
The bridge parameters		
1st Eigen-frequency	[Hz]	3.96
Bridge length	[m]	30.0
Flexural Stiffness EI	[Nm]	1.56×10^{10}
Mass per unit length ρ	[kg/m]	3000
Elements number		300

Simulated vibration

Intact

Damage 1 Edge

50% decrease of EI
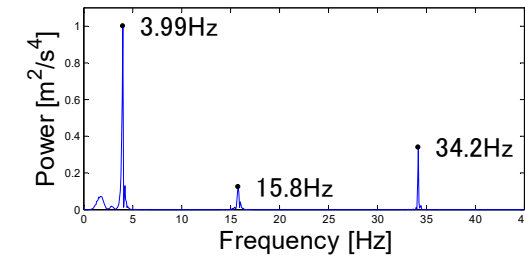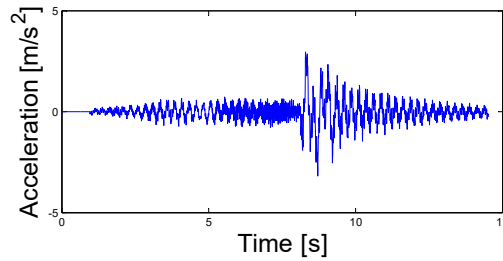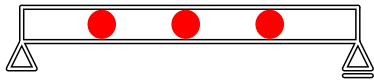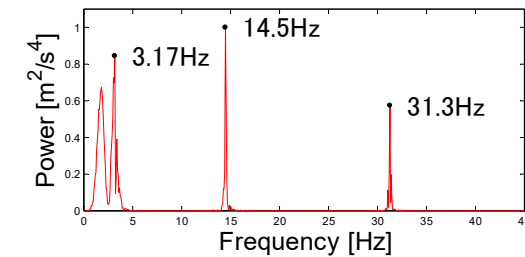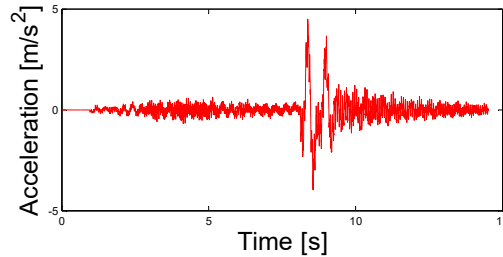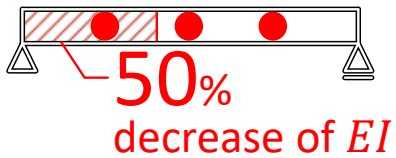
Damage 2 Mid-span
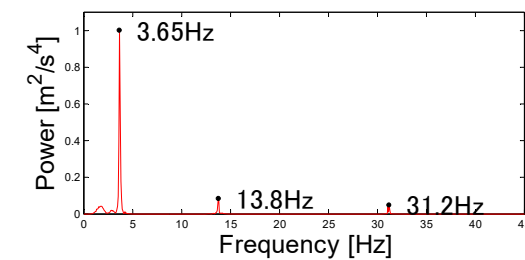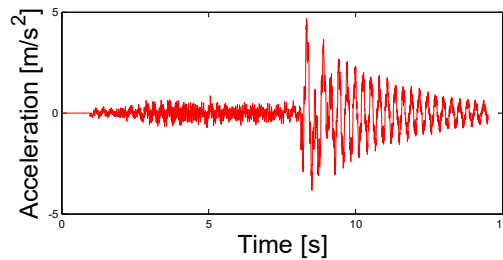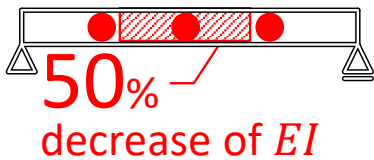
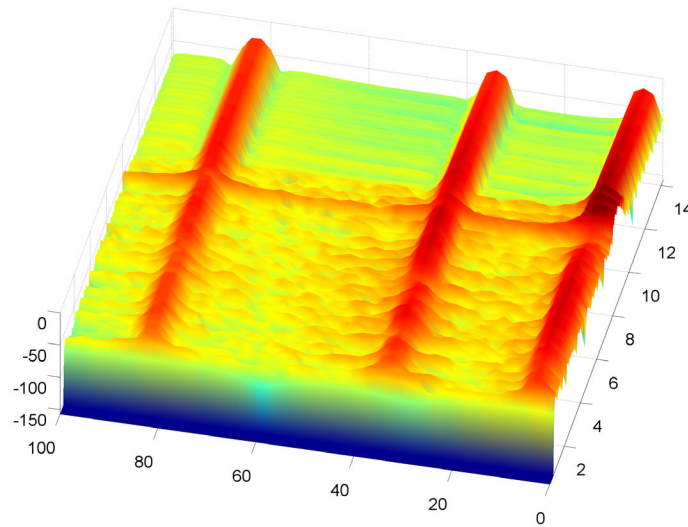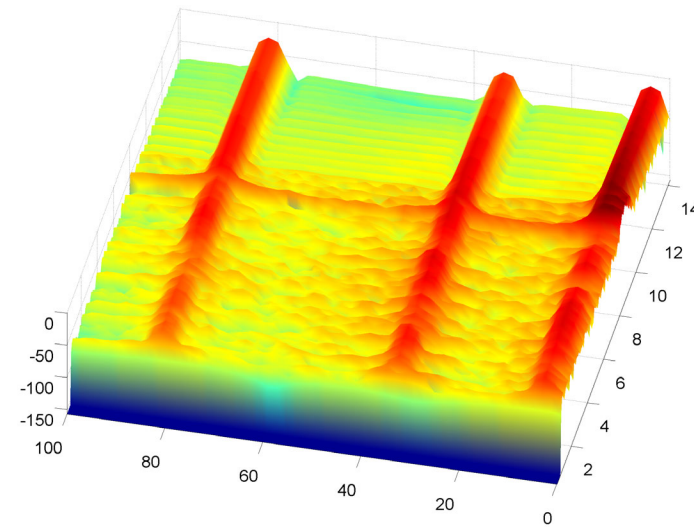50% decrease of EI
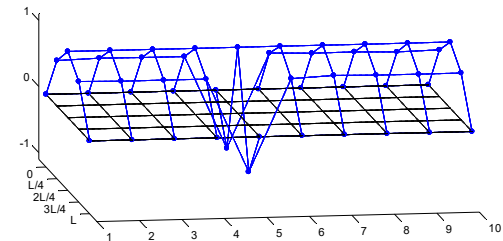
Result of ST-FT
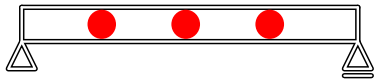
Too much information to distinguish differences

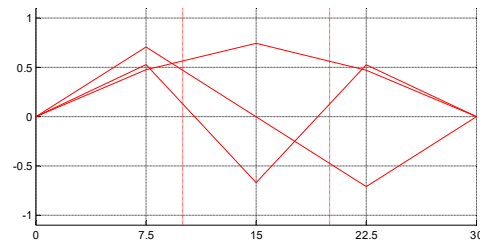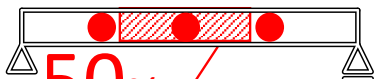

Intact

Damage 1

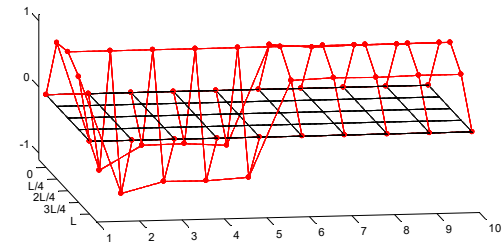# Comparison between SVD and ST-SVD

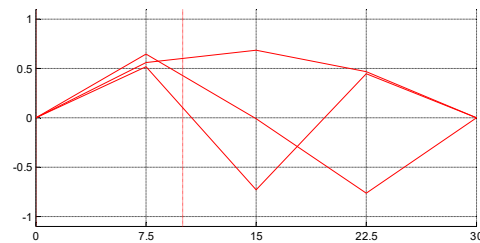**Intact**
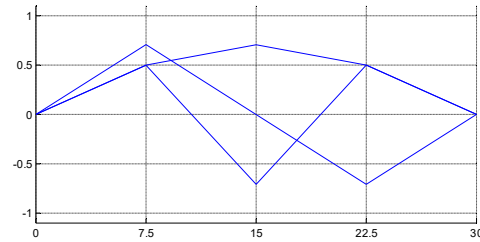
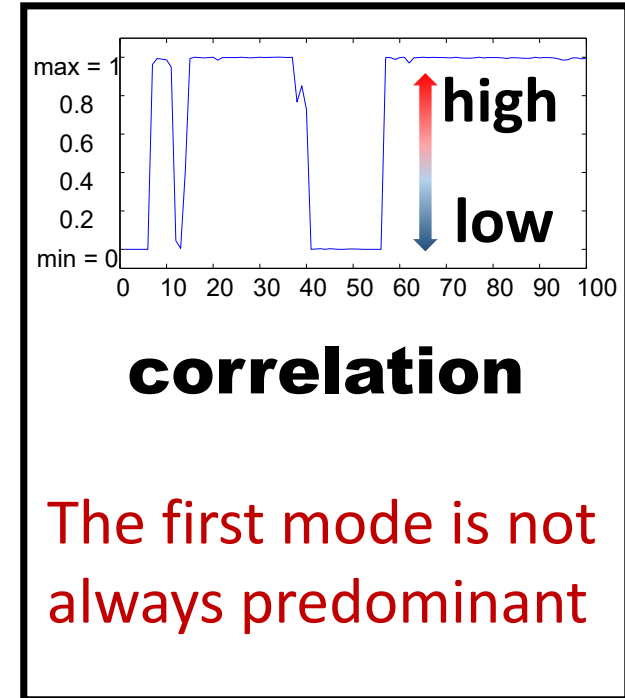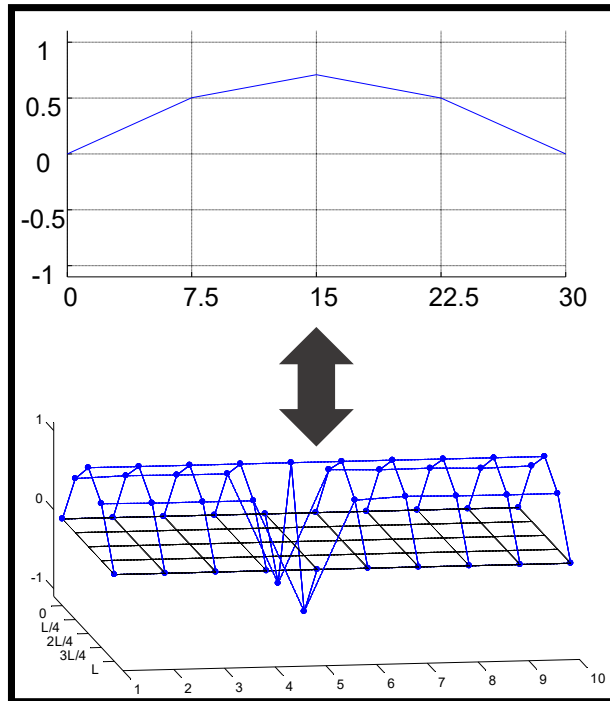**Damage 1 Edge**
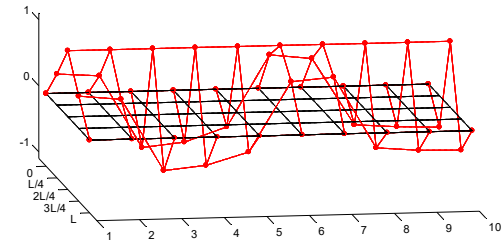
50% decrease of EI

Damage 2 Mid-span

50% decrease of EI

Application of MAC

Compare with its Similarity
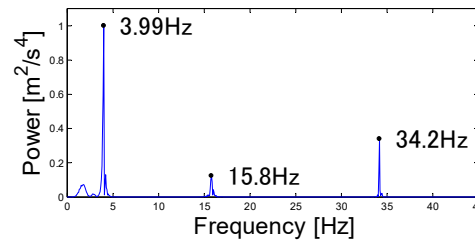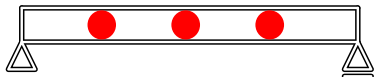

correlation

The first mode is not always predominant

Small damage

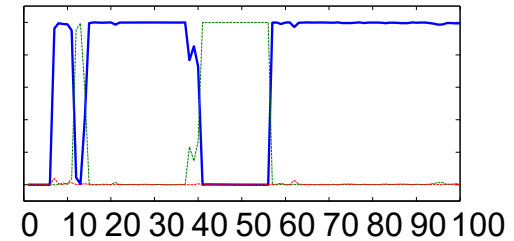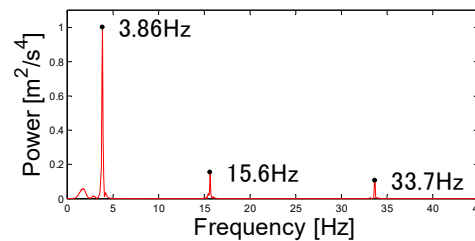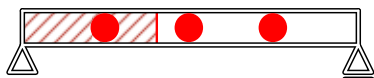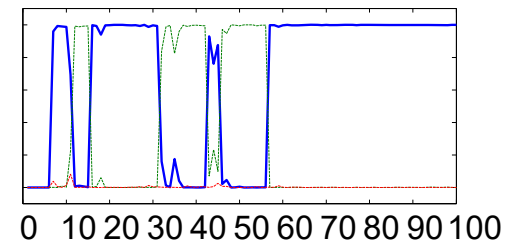# Easily detect difference   Similar to the first mode

Intact

Damage 1

Conclusion

ST-SVD is proposed in this study.
By **numerical verification**, its efficiency is examined.

  1) Very sensitive to bridge damage
  2) Also very sensitive to traffic loadings

Next study

  1) To find the method to consider the traffic effect
  2) To make more friendly index