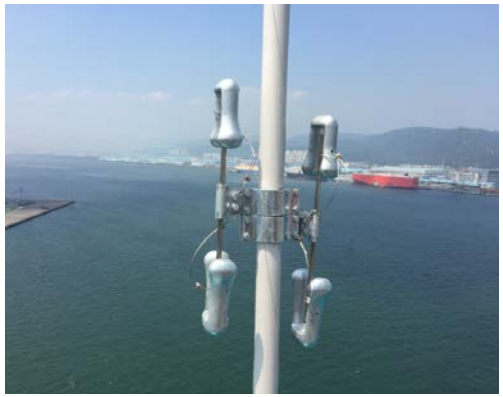
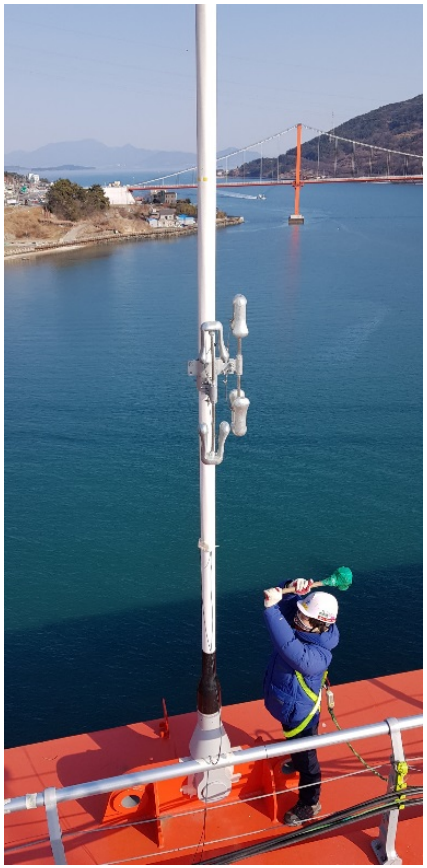
INTRODUCTION TO STOCKBRIDGE DAMPER BY

TE Solution





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WIND-INDUCED
VIBRATION PROBLEMS

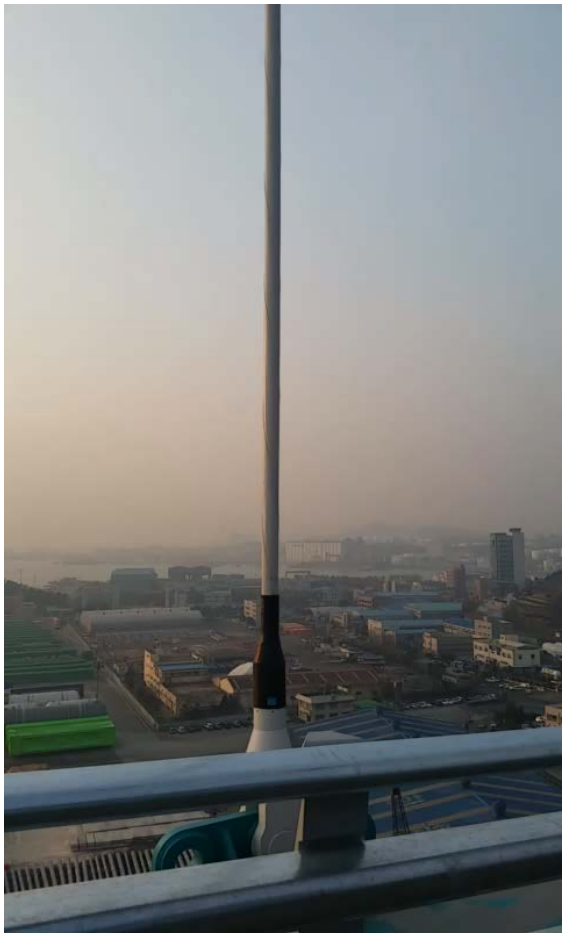
Wind-induced Vibration Problems

Rain-Wind Induced Vibration(Cable, Keumhodo-Ando Br. Korea)

■ Date = 2009 ■ Under Construction Stage ■ Weather Condition = Wind + Rain

Wind-induced Vibration Problems

Vortex Induced Vibration(Hanger Cable, Korea)



Wind-induced Vibration Problems

Vortex Induced Vibration(Cable, Pyeong Taek Br. Korea)

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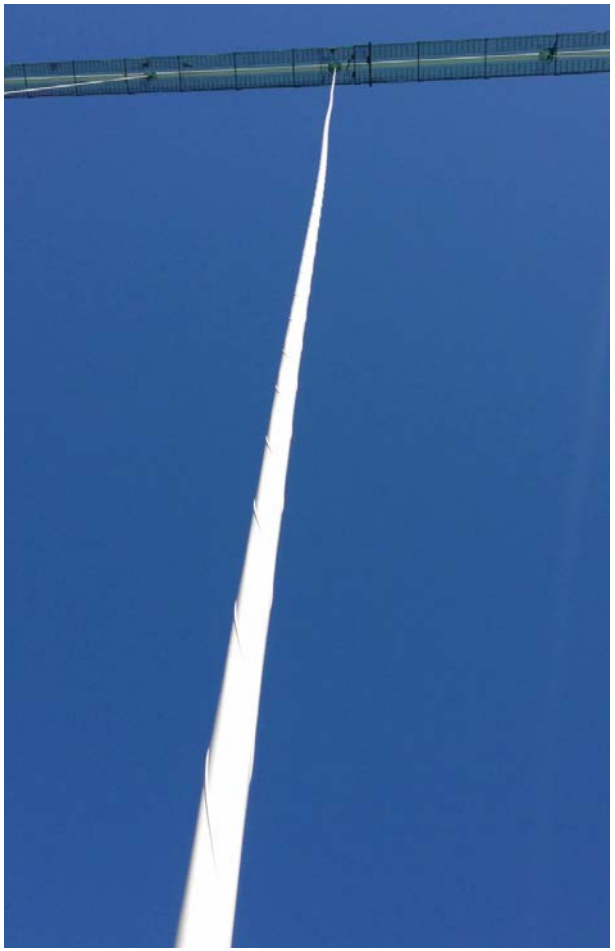
HOW TO CONTROL VIBRATION WITH STOCKBRIDGE DAMPER

Cable Vibration on Bridges

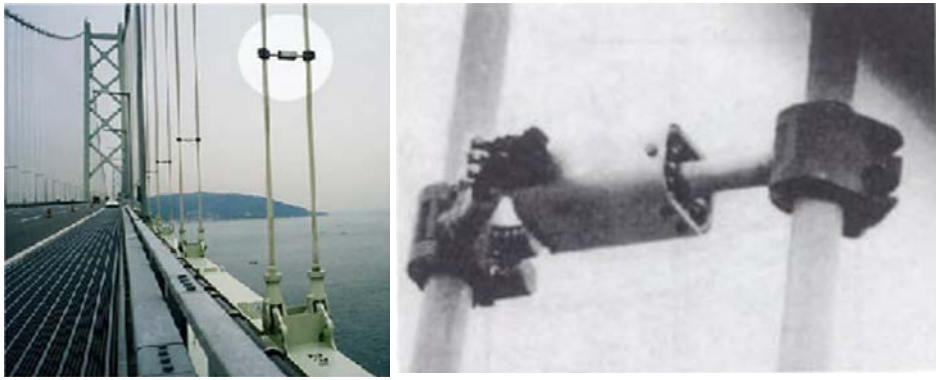
- Severe Cable Vibration Frequently Observed on Suspension Bridge and Cable Stayed Bridge can be Potentially Dangerous !



Various Types of Cable Dampers

Existing Cable Dampers for suspension bridge

Clamp (Great Belt East Bridge)



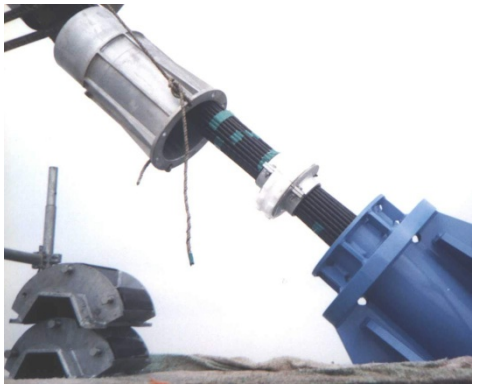
High damping rubber damper (Akashi Bridge)

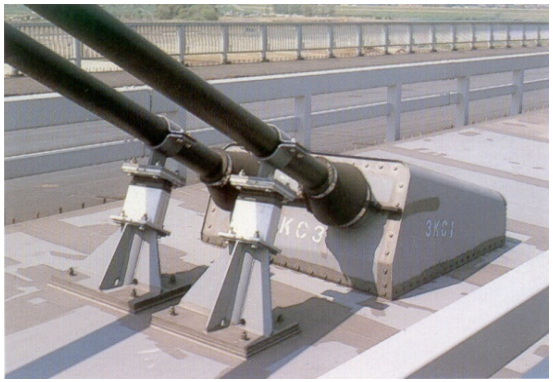
High damping rubber damper (Kurushima Bridge)

High damping rubber damper (Akinada Bridge)

Various Types of Cable Dampers

Existing Cable Dampers for cable-stayed bridge





Various Types of Cable Dampers

Problems with Existing Cable Dampers

- *Expensive*
- *High installation and maintenance cost*
- *Need for installation of supporting structures*
- *Control forces is delivered to the cable via supporting structure*

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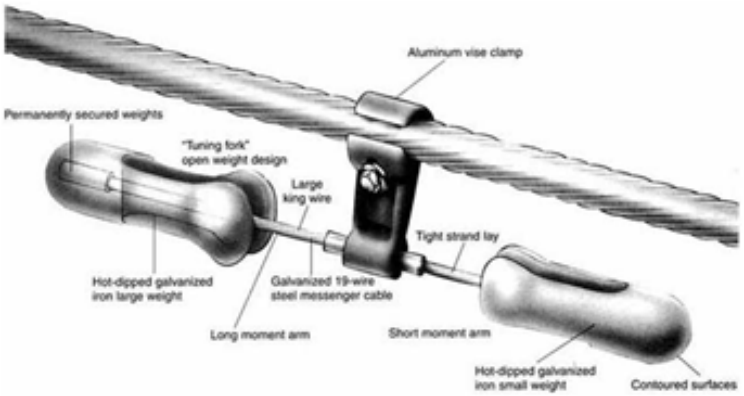
STOCKBRIDGE DAMPER
BY TESOLUTION

Introduction to Stockbridge Damper

1. What is Stockbridge Damper?

→ Stockbridge damper is a type of tuned mass damper to suppress vortex induced vibration of cables, and it consists of two masses with a shape of bell or horse shoe and messenger cable and a clamp used to fix it to the cable to control vibration.



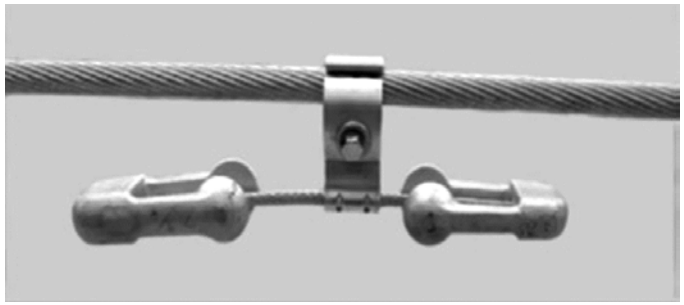
Components of Stockbridge Damper

2. SB Damper Characteristics

- Messenger cable of SB Damper, which is used as a stiffness component also works as damping component, so it is very simple in design and requires minimum maintenance and very economical.
- SB Damper has the advantage of TMD, but also has the advantage of multi mode vibration control and economy, so it is a very effective measure against cable vibration on various bridges.

SB Damper Field Application

SB Dampers can not only be used on transmission lines and bridge cables, but also used on various structures such as spoke cables of Ferris wheel and supporting cables of the stadium



Transmission Line

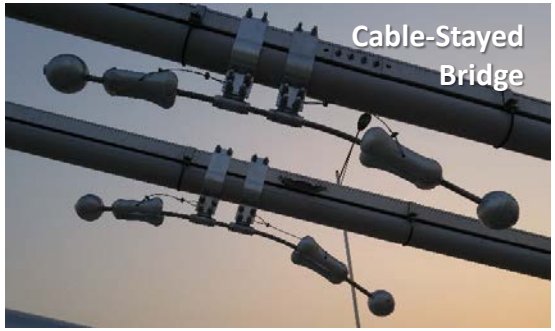
Wembley Stadium

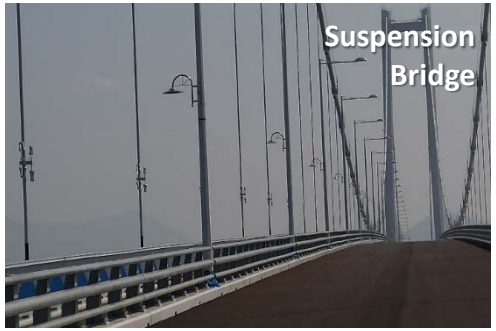
London Eye

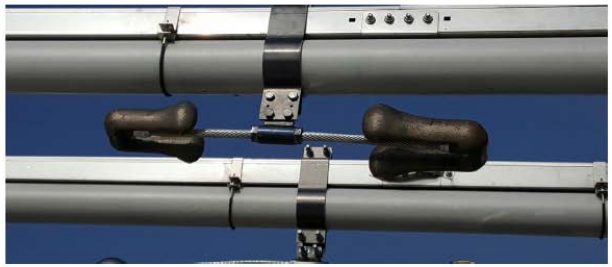
TESolution's Stockbridge Damper

SB Dampers of various types for different application

Hybrid Type SB Damper







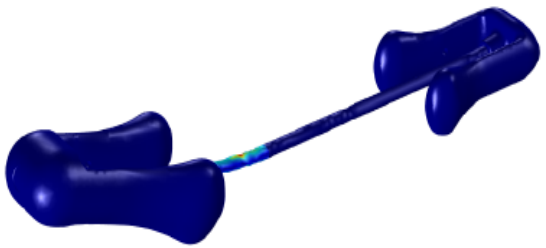
High-Frequency SB Damper

Low-Frequency SB Damper

High-Frequency SB Damper for Cable Stayed Footbridge in Action

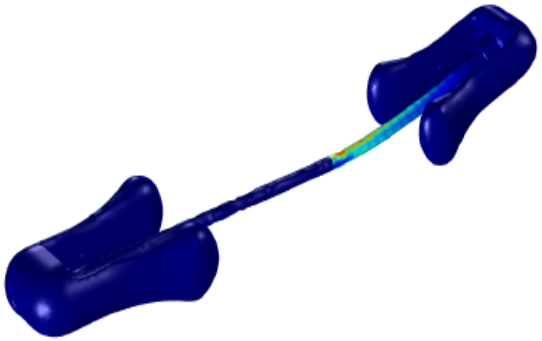
TESolution's Stockbridge Damper

Multi-Mode Response for multi-mode vibration control with Asymmetric Configuration of Mass

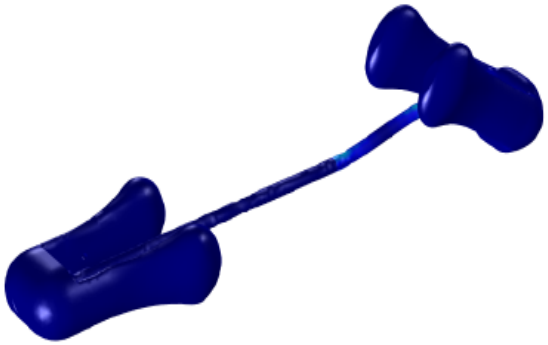


(a) 1st vertical bending mode of large mass side (5.9357 Hz)

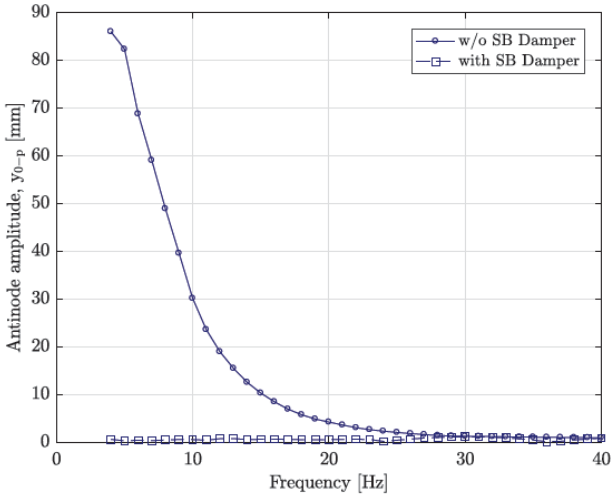
(c) 2nd vertical bending mode of large mass side (18.165 Hz)



(b) 1st vertical bending mode of small mass side (9.8827 Hz)



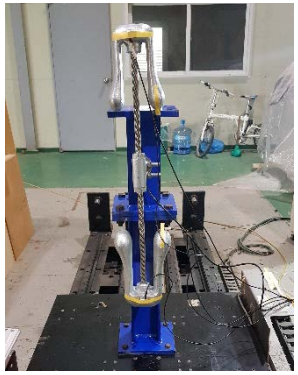
(d) 2nd vertical bending mode of small mass side (32.249 Hz)



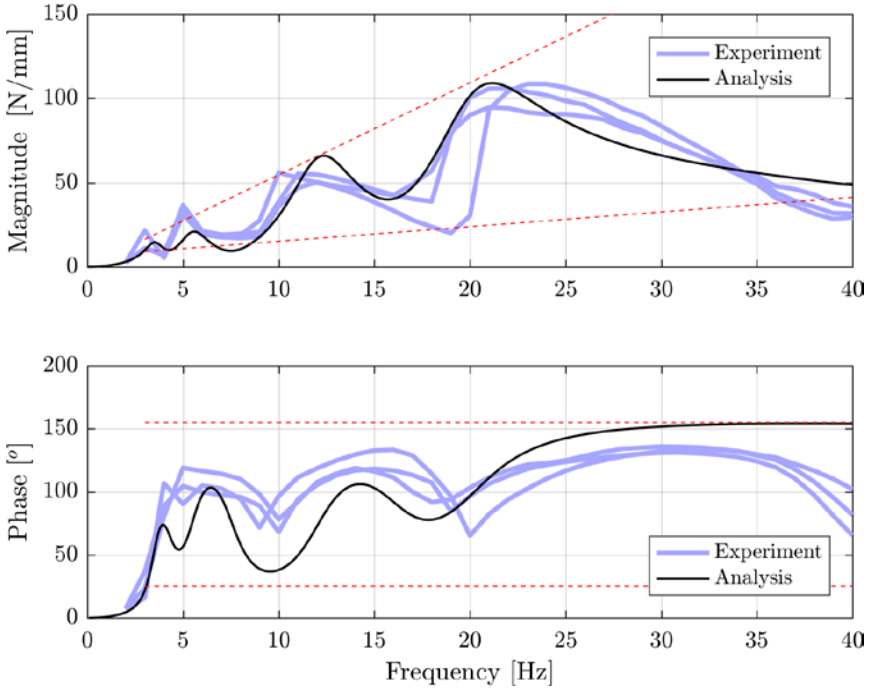
▶ Reduction in Amplitude of Hanger Cable with the installation of Stockbridge Damper

SB Damper Analysis and Testing

- **Analysis on the SB Damper dynamic characteristics and comparison with the test results**
  - Comparison between analysis on the dynamic characteristics of SB Damper and actual test in accordance with IEC Standard 61897
  - Secured dynamic stiffness and phase that are fit for controlling the cable vibration at target frequency range



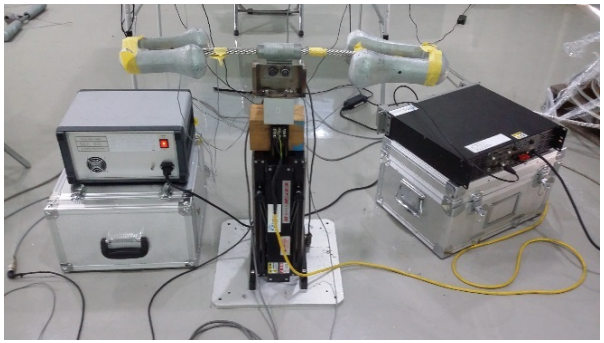
Dynamic Test in accordance with IEC 61897

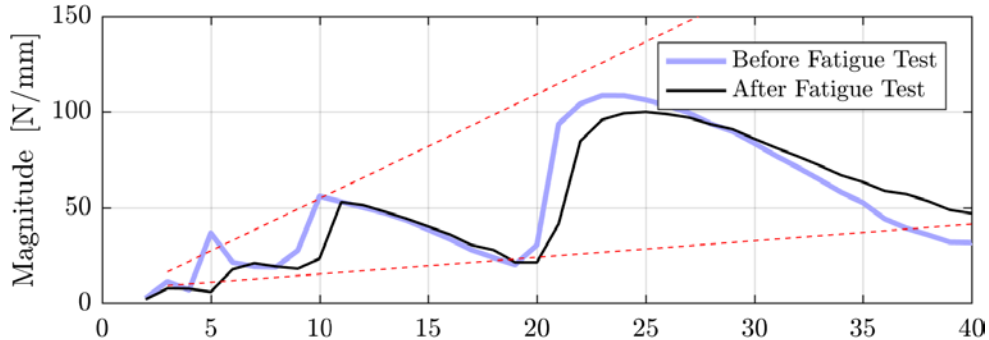


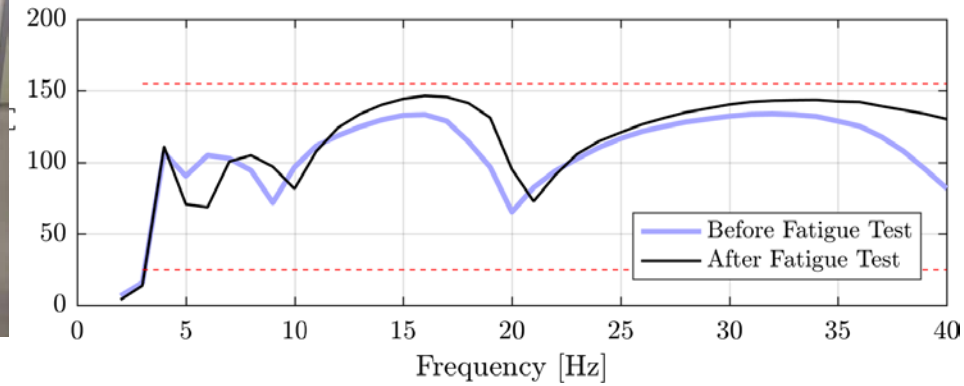
▶ Dynamic characteristics of the analysis and the actual test results are in good agreement!

SB Damper Analysis and Testing

- SB Damper Fatigue Test Result
  - Fatigue testing from the SB Damper samples that has passed the dynamic test (IEC Standard 61897)
  - Not much difference in dynamic characteristics before/after the fatigue testing and secured dynamic stiffness and phase that are fit for controlling the wind vibration on the cables
  - No damage to the product after 10 million cycles of fatigue testing which proves durability







Fatigue test with 10 million cycles

Onsite Installation & Performance Verification

- Onsite Installation

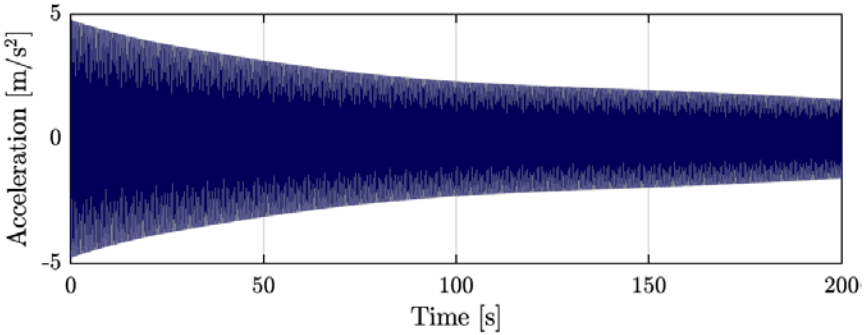
Pick the installation location of SB damper after analysis on the stay cable

< SB Damper Installation >

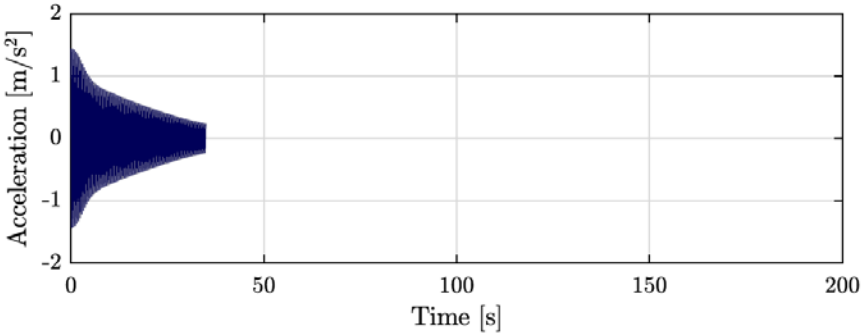
< SB Damper after installation on Cable Stayed Bridge >

- SB Damper Performance Verification

1) Without Damper (Damping Ratio=0.0307%)



2) With Damper (Damping Ratio=0.316%)



After SB Damper Installation

Performance of SB damper

Drastic Reduction in Vibration after the Installation of SB damper on the hanger cable of suspension bridge

Cable Damper Comparison

	SB Damper	Oil Damper	High Damping Rubber Damper
Installation Photo			
Principle behind Damping Force	Using inertial force to control the cable vibration	Damping force that is generated by resistance when the oil inside the piston goes through the orifice	Damping force generated when the shape of the rubber morphs in shear direction
Performance and application on bridges	Proved good performance after recent installation on suspension bridges and cable stayed bridges	Most well known cable damper for controlling the vibration on the stay cables of suspension bridges	Proven its performance with application on various bridges around the world
Maintenance Issues	Very simple design and good durability and also very easy to replace if damaged	Twisting of Damper or transforming of fixing jig can cause leakage in oil inside the piston	Thermal degradation, damage to the rubber, unbolting of fixing bolt issues
Cost	**Low**	**High**	Mid
Feasibility	◎	○	△

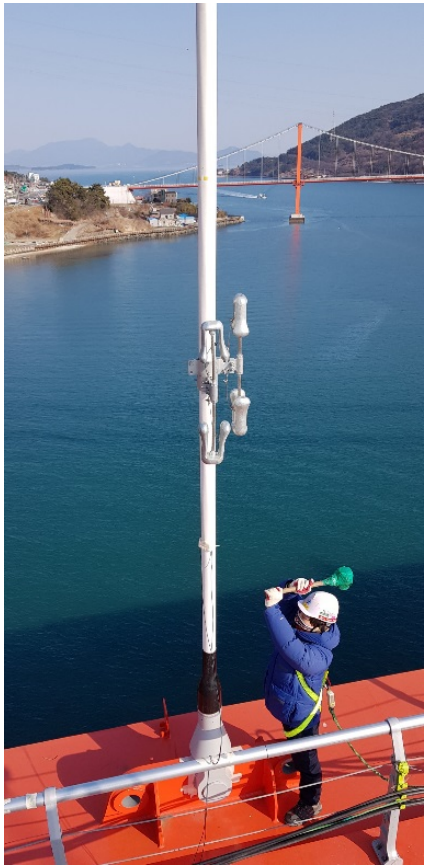
TESolution Track Record

<Ulsan suspension bridge, Korea>

<Palyung suspension bridge, Korea>

<Pyeongtaek cable stayed bridge, Korea>

<"H" suspension bridge, China>



<2nd Namhae suspension bridge, Korea>

Thank You

for your attention.