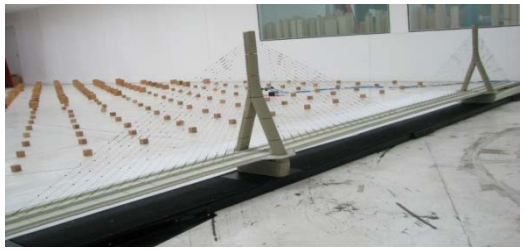
TE Solution
Total Engineering Solution
in Wind Engineering and Vibration Control

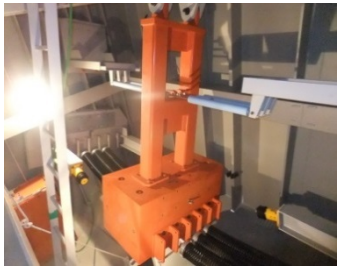
# Introduction of TESolution












# Contents

# CEO's Message

CEO Yun-seok KIM

Our company was established in February 2001, with the goal to provide better life to our clients through our accurate evaluation of safety and serviceability of various structures and our solutions to improve them, based on our differentiated technical expertise and accumulated experience in the field of Wind Engineering and Vibration Control.

**As to the field of Wind Engineering**, TESolution provides solutions for safer and better life with evaluation on serviceability of buildings and bridges, through wind resistance stability tests, wind induced vibration tests, and evaluation on wind environment based on our highest level of expertise and technically advanced facilities.

**As to the field of Vibration Control**, TESolution provides solutions to improve the quality of living environment through our vibration control devices that reduce or suppress the vibration occurred from wind load, seismic load, or traffic load on various structures.

**We promise our very best to provide satisfactory results for our clients with our differentiated technical services and our continuous R&D efforts.**

**CEO of TESolution**
**Dr. Kim, Yun Seok**

# Vision

## Top

**Strive to be leaders in the field of Wind Engineering & Vibration Control through the higher levels of product quality and customer service**

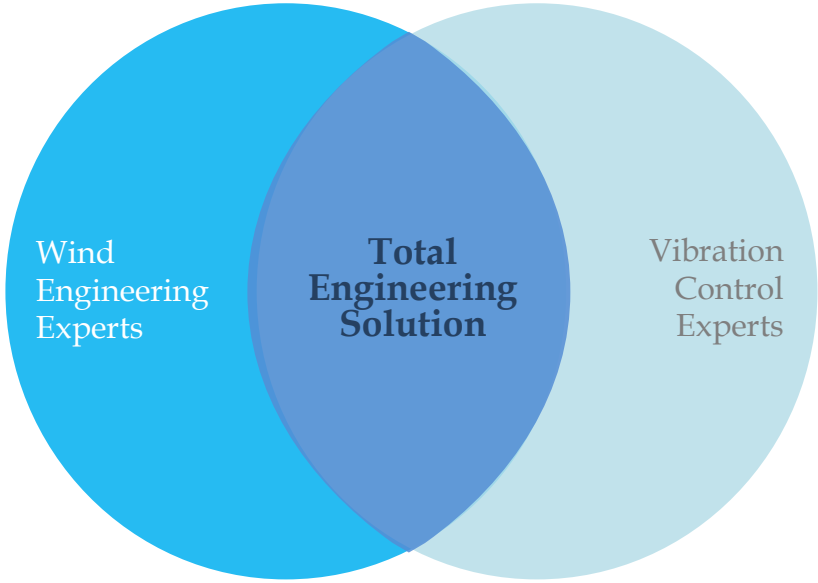
## Harmony

**Promote greater harmony with people & nature by providing the best solution to our customers**

## Differentiate

**Differentiate with continuous R&D and comprehensive solution**

# People




**"We strive to provide Total Engineering Solution in Wind Engineering & Vibration Control."**

# Organization Chart

TE Solution

- Market Development
- Structure Aerodynamics
- Bridge Aerodynamics
- Vibration Control
- R&D

# Location


TESolution Co., Ltd.
142 Seungjin-gil Gongdo-eup, Anseong-si,
Gyeonggi-do, 17563 Korea

Head Quarter

Laboratroy

# History

**2001** Foundation of TESolution

**2003** Installation of the first TMD for bridge in Korea (2nd Jindo Bridge)

**2004** Installation of the first TMD for residential building in Korea (Centum City, Busan)

**2005** Moved HQ to Anseong with new office building and wind tunnel facilities

**2007** Installation of the first AMD in Korea (Lotte-Hotel Ulsan)

**2010** Installation of the biggest TMD in Korea (160t. Posco E&C HQ)

**2011** Completion of Test Tower Development

**2012** Marked 150 Wind Tunnel Tests for Bridges

**2012** Built Korea's first HMD at Tecno Mart

**2014** Marked 200 Wind Tunnel Test for Buildings

**2014** Certified with ISO9001:2008, ISO140001, OHSAS18001:2007

**2015** Dubai Ferris Wheel TMD Project

Taipei Treasure Garden Res. Building Project

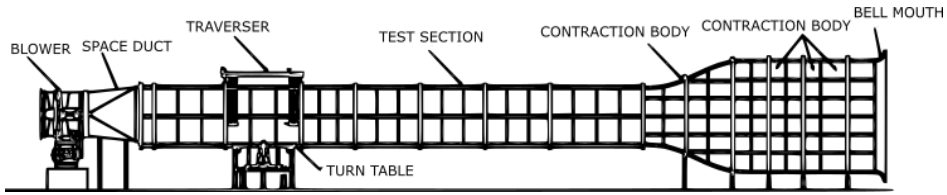
**2016** New York Ferris Wheel TMD Project

R&D of Stockbridge Damper

# Facility & Equipment

**Boundary Layer Wind Tunnel** | Wind Tunnel for Section Model | Test Tower | Structural Laboratory

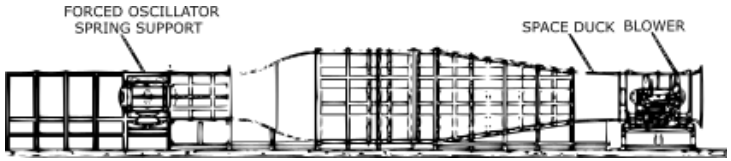

| | |
|---|---|
| Type | Open-circuit (Suction) |
| Test Section | 8.0m(w) x 2.5m(h) x 23.2m(l) |
| Wind Speed | 0.3 ~ 11.0m/s |
| Turbulence Intensity | 0.5% , Wind Speed Deviation ±1.0% |
| Suction Fan | 3EA, 132kW |



# Facility & Equipment

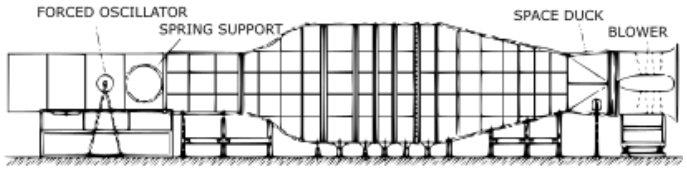


## Mid-size 2D Wind Tunnel




| Type | Test Section Dimension | Wind Speed |
|---|---|---|
| Eiffel-type | 1.5 m (W) x 2.0 m (H) x 7.5 m (L) | 0.3m/s ~ 25.0 m/s |

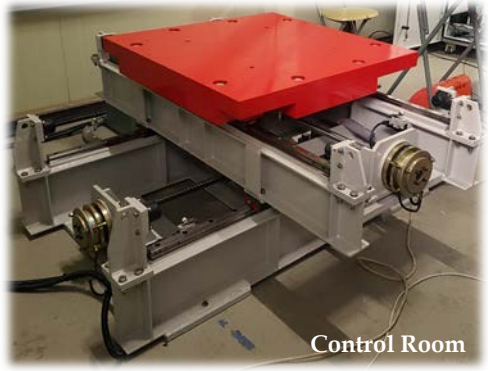
## Small-size 2D Wind Tunnel

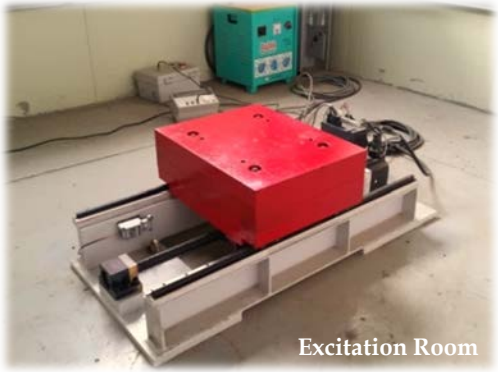



| Type | Test Section Dimension | Wind Speed |
|---|---|---|
| Eiffel-type | 1 m( W) x 1.5 m (H) x 6 m (L) | 0.3m/s ~ 21.0m/s |

# Facility & Equipment





Control Room


Excitation Room

| | |
|---|---|
| **Composition** | Control Room |
| | Excitation Room |
| **Heights** | 5 Stories (20m Height) |
| **Description** | Performance testing for developed vibration control devices |

# Facility & Equipment



**1st Structural Laboratory**

**2nd Structural Laboratory**

# Lead Engineers

## Description

Dr. Yun-seok Kim has worked as the chief of wind engineering & vibration control department in Hyundai Institute of Construction Technology for over 10 years. As the pioneer of vibration control system in Korea, he installed the first Hybrid Mass Damper in Korea on the control tower of Incheon International Airport. He has also conducted many wind engineering studies of high-rise buildings and long span bridges during his tenure. He established TESolution Co., Ltd. in 2001, and has led the operation of over 300 wind tunnel tests and vibration control system projects. He is also contributing to the academia of wind engineer as the Vice President of Wind Engineering Institute of Korea.

## Dr. Yun-seok, KIM

**CEO**
TESolution

## Education

- Ph.D. in Civil Engineering. Korea Advance Institute of Science & Technology (KAIST), 1992
- M.Sc. in Civil Engineering. Kyoto University Graduate School (Japan), 1988

## Experience

- 2002~Present: CEO of TESolution
- 1997~Present: Vice President of Wind Engineering Institute of Korea
- 1993~2002: Principal Research Engineer of Hyundai Engineering & Construction
- Adjunct Professor of KAIST, Sungkyunkwan University, Kyonggi University

# Lead Engineers

## Dr. Seok-jun, JOO

**Managing Director**
TESolution

## Description

Dr. Seok-joon Joo is a specialist in the field of wind-induced vibration control system and wind tunnel test. He obtained his Doctor's degree in 2000, with study on Robust Control of High-rise Building. As one the leading Researchers at Wind Engineering & Vibration Control Department at Hyundai Institute, he played a vital role in development of the first Hybrid Mass Damper in Korea. He is one of the foundering members of TESolution, and has conducted over 30 vibration control projects and 100 wind tunnel tests. He has played a major role in obtaining number of patents such as Vibration Control Device of Construction Structure and Vibration Control and Elasto-plastic Vibration Control Device.

## Education

- Ph.D in Architectural Engineering, Seoul National University, 2000
- M.Sc. in Architectural Engineering, Seoul National University, 1995
- BA in Architectural Engineering, Seoul National University, 1991

## Experience

- 2002~Present: Director of TESolution
- 2010~2011: Visiting Scholar of University of Western Ontario (Canada)
- 2000~2002: Senior Research Engineer of Hyundai Engineering & Construction
- 1998~1999: Instructor of Seoul National University of Science & Technology

# Lead Engineers

## Dr. Seung-woo LEE

**Director**
TESolution

## Description

Dr. S.W. Lee received his M.S. in civil engineering from KAIST in 1998. He has studied vibration isolation of bridge. After obtaining a master's degree, he worked as a researcher of wind engineering & vibration control department at Hyundai Institute of Construction Technology. In 2004, he joined TESolution and started a course of Ph.D degree at KAIST. He obtained a Ph.D with study of wind engineering and energy harvesting in 2013. During his tenure at TESolution, he has conducted over 150 wind tunnel tests and relevant analyses for wind resistant design of bridges. He has also carried out large numbers of R&D projects regarding bridge and vibration. He is a specialist in the fields of bridge aerodynamics and vibration control.

## Education

- Ph.D in Civil Engineering (Korea Advanced Institute of Science and Technology), 2013
- M.Sc. in Civil Engineering. Korea Advance Institute of Science & Technology (KAIST), 1998
- BA in Civil Engineering. Korea Advance Institute of Science & Technology (KAIST), 1996

## Experience

- 2004 ~ Present: Director of TESolution
- 2013 ~ Present: Director of Wind Engineering Institute of Korea
- 2014 ~ 2015: Visiting Researcher of University of Arizona (US)
- 2000 ~ 2004: Research Engineer of Hyundai Engineering & Construction

# Lead Engineers

## Dr. Saang-bum KIM **Director** TESolution

## Description

Dr. Saang-bum Kim has worked in the area of bridge and wind engineering. Since he received his Ph.D., he has researched on the vibration control and system identification for large infra structures. From 2005 to 2015, he was a principal research engineer at Samsung C&T with the main research projects: fluid-structure interaction analysis for bridge aero-dynamics, aero-elastic analysis for Mersey gateway bridge, performance evaluation of cable dampers (Incheon/Wando bridge), bridge-train interaction analysis for maglev system, and experimental modal analysis with wireless sensor network. Now he is actively working on the development of vibration control system.

## Education

- Ph.D. in Civil Engineering, Korea Advance Institute of Science & Technology (KAIST), 2000
- M.Sc.. in Civil Engineering, Korea Advance Institute of Science & Technology (KAIST), 1993
- BA in Civil Engineering, Korea University, Korea, 1991

## Experience

- 2016 ~ Present : Director of TESolution
- 2005 ~ 2016 : Principal Research Engineer of Samsung C&T
- 2005 ~ 2005 : Research Associate of KAIST
- 2003 ~ 2004 : Visiting Scholar of University of Illinois Urbana-Champaign (USA)
- 2001 ~ 2003: Visiting Scholar of Notre Dame (USA)

# Lead Engineers

## Dr. Dong-woo, KIM **Director** TESolution

## Description

Dr. D.W. Kim received his M.S. in architectural engineering from KIT(Kumoh National Institute of Technology), Korea in 1999, where He studied wind engineering of building. He obtained his Ph. D. degree with study of the wind-induced response of tall buildings with various elevation and plan shapes from KIT, Korea in 2003. From 2004 to 2007, he has worked as a researcher of Industry-academic Cooperation Foundation in KIT, Korea. He has conducted over 150 wind tunnel test projects of buildings, since joining TESolution in 2008. He is a specialist in the field of wind tunnel test of buildings and wind climate analysis.

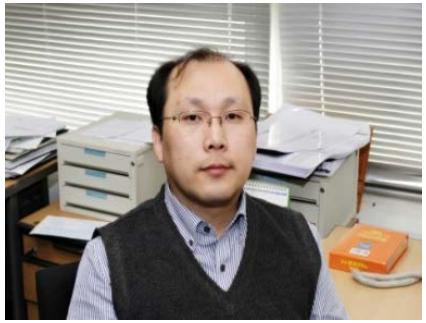
## Education

- Ph.D. in Architecture Engineering (Kumoh National Institute of Technology), 2003
- M.Sc.. in Architectural Engineering, Kumoh National Institute of Technology, Korea, 1999
- BA. in Architectural Engineering, Kumoh National Institute of Technology, Korea, 1997

## Experience

- 2007 ~ Present: Director of TESolution
- 2003 ~ 2007: Principle Researcher & Associate Professor at Kumoh National Institute of Technology

# Lead Engineers



## Description

Dr. Seok Heo graduated in Dongguk University with Ph. D under prof. M. K. Kwak. After graduation, he worked in University of Nevada, Reno as Post-doc (2003-2005), Konkuk University as Research Professor (2005-2009), and research center of Judico co. as director (2012-2013). He is a specialist in active vibration control of smart structures. He joined TESolution in 2015, and currently in vibration analysis and vibration control of the structures.

## Dr. Suk, HEO

**General Manager**
TESolution

## Education

- Ph.D. in Mechanical Engineering, Dongguk University, 2003
- M.Eng. in Mechanical Engineering, Dongguk University, 2000
- B.Eng. in Mechanical Engineering, Dongguk University, 1998

## Experience

- 2015 ~ Present: General Manager of TESolution
- 2012 ~ 2013 Director of Judico Co. Research Center
- 2005 ~ 2009: Research engineer & instructor in Kumoh National Institute of Technology, Korea
- 2003 ~ 2005: Post-doc., University of Nevada

# Awards

Certificate No : 160602 - 01328

CERTIFICATE OF INNO-BIZ

Company : TESOLUTION CO.,LTD
C E O : YOUN SEOK KIM
Address : 142, SEUNGJIN-GIL, SEUNGDU-RI, ANSEONG-SI, GYEONGGI-DO, REPUBLIC OF KOREA
Validity of Certificate : 2016. 12. 29 ~ 2019. 12. 28

This is to certify that the above-mentioned Company is an INNO-BIZ enterprise in accordance with Article 15 of the Act on Promotion of Technology Innovation for SMEs.

DEC 29, 2016

Administrator

Small and Medium Business Administration
Republic of Korea

Inno-Biz (SMBA)

NO 2016-138

The Best Value
Certified by Gyeonggi Province
경기도유망중소기업

Certificate of Authentication

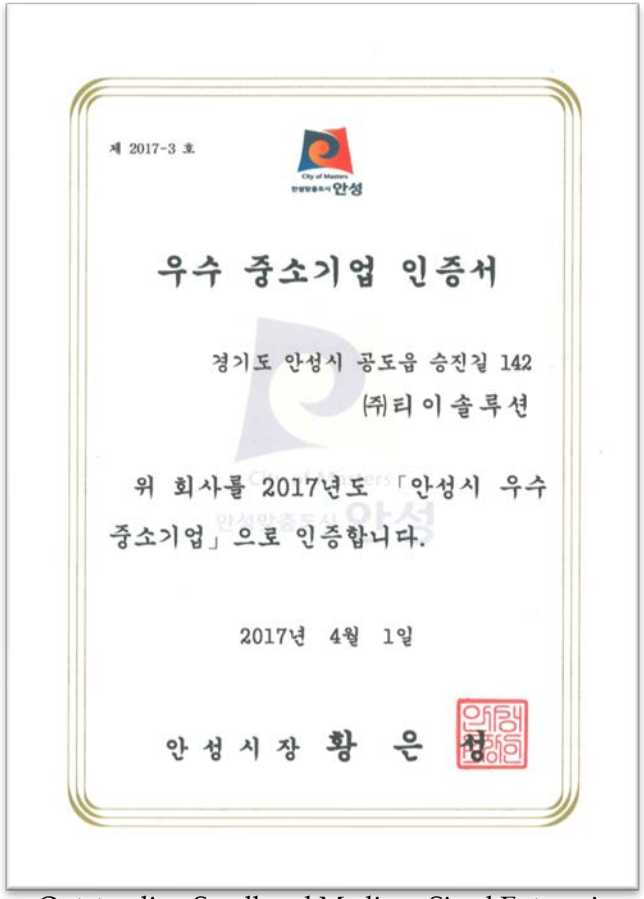
TESOLUTION CO.,LTD
Period of validity : 4 Oct, 2016 ~ 3 Oct, 2021

This document certifies that the above company has been selected as a Promising Small and Medium-Sized Enterprise by the Gyeonggi Provincial Government.

4 October, 2016

Governor of Gyeonggi Province
KP Nam

Promising Small and Medium-Sized Enterprise
(Province of Gyeonggi-do)



제 2017-3 호

안성

우수 중소기업 인증서

경기도 안성시 공도읍 승진길 142
㈜티 이 솔 루 션

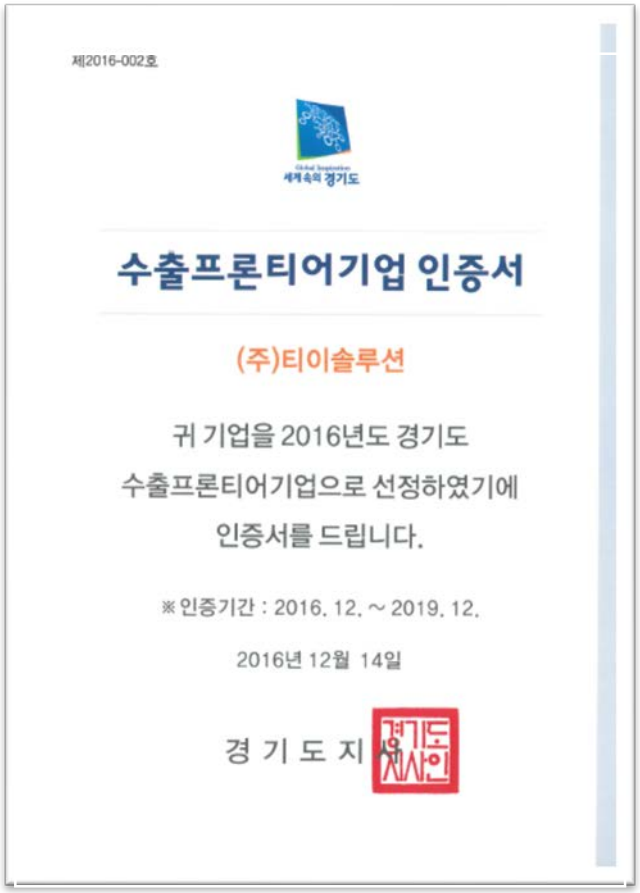
위 회사를 2017년도 「안성시 우수 중소기업」으로 인증합니다.

2017년 4월 1일

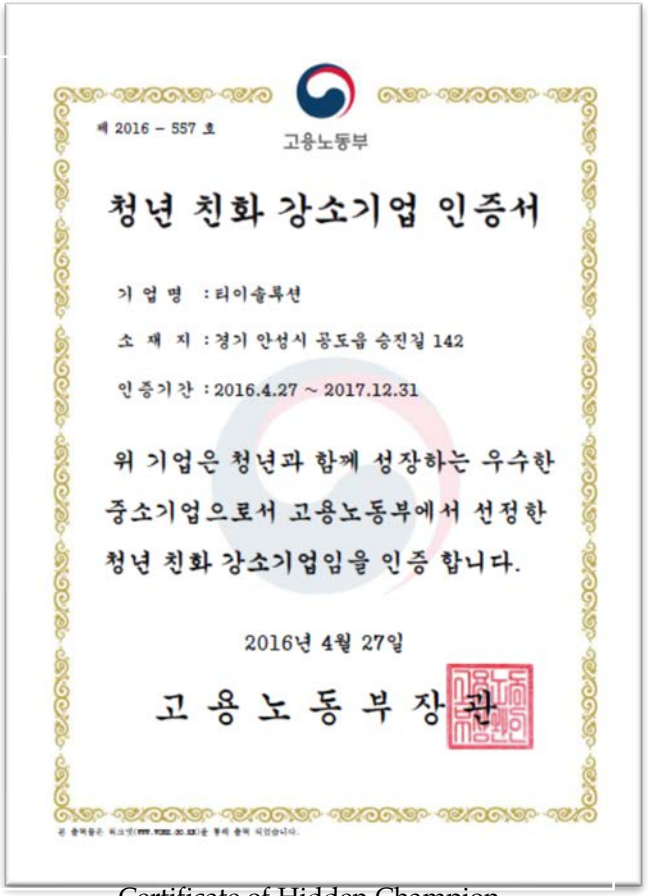
안 성 시 장 황 은 성

Outstanding Small and Medium-Sized Enterprise
(City of Anseong-si)

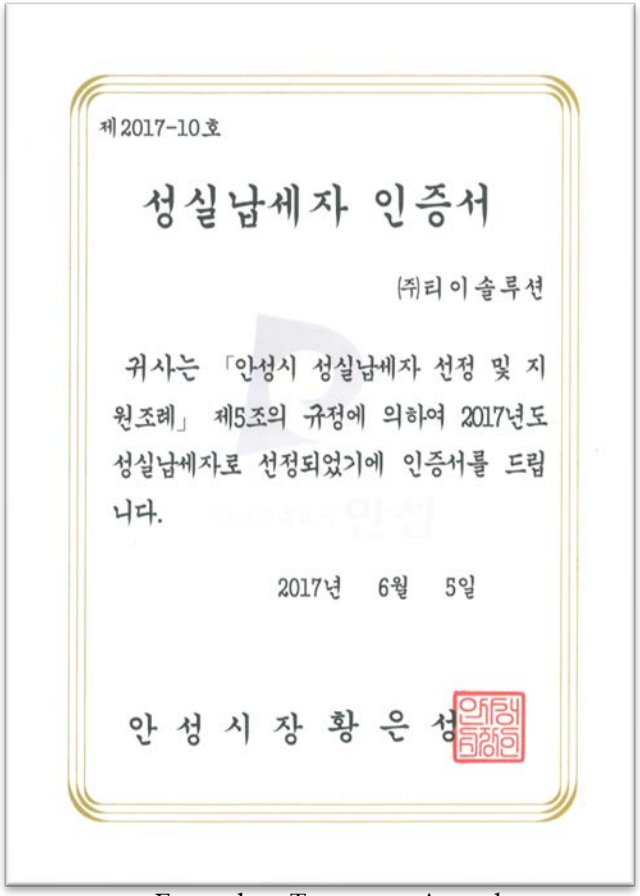
# Awards




Export Frontier (Province of Gyeonggi-do)

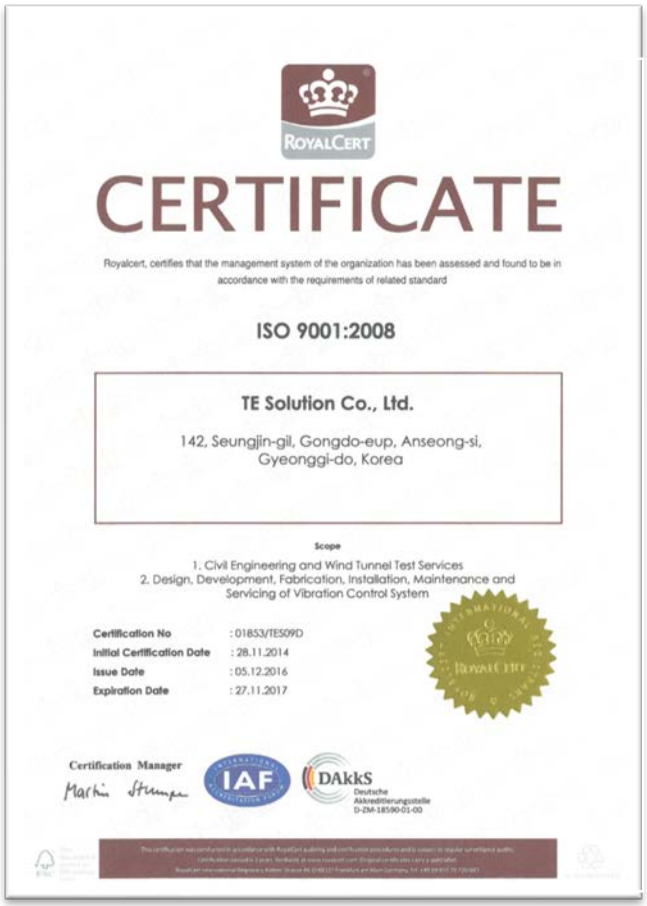



Certificate of Hidden Champion
for Young Work Force
(Ministry of Employment and Labor)

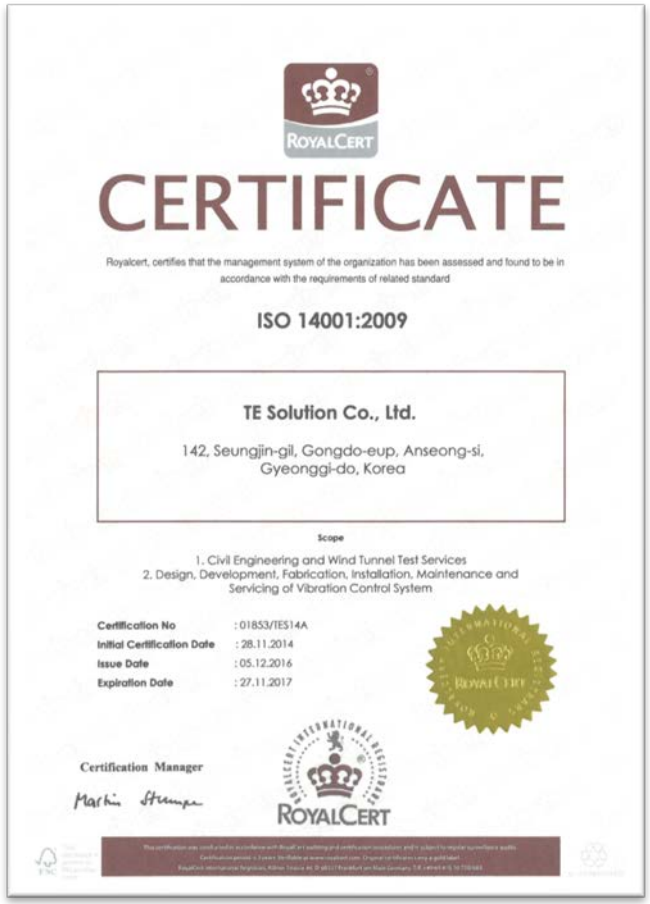



Exemplary Taxpayers Award
(City of Anseong-si)

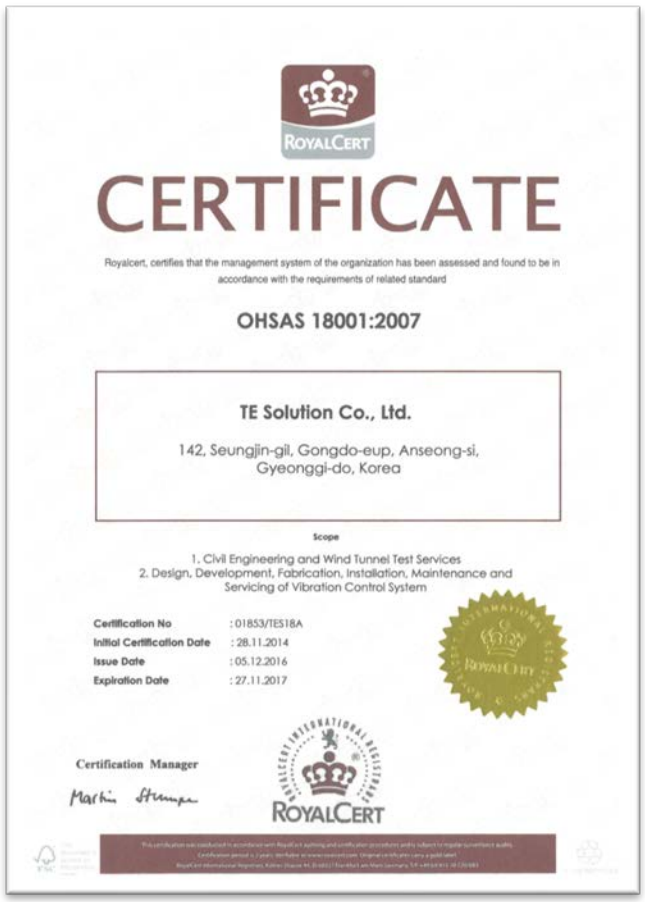
# Certificates




ISO 9001: 2008



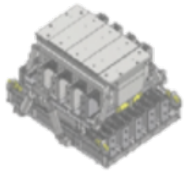

ISO 14001: 2009




OHSAS 18001: 2007

# Expertise

**Total Engineering Solution in Wind Engineering & Vibration Control**



**Vibration Control Devices**

**Structure Aerodynamics**

**Bridge Aerodynamics**

**Analytics of Wind & Vibration**

▶ **Vibration Control Devices**

- *-Tuned Mass Damper*
- *-Active Mass Damper*
- *-Hybrid Mass Damper*
- *-Stockbridge Damper for Bridge Cables*

▶ **Wind Tunnel Testing & Aerodynamic Analysis**

- *-High Frequency Force Balance Test*
- *-Wind Pressure Test*
- *-Aeroelastic Model Test*
- *-Pedestrian Level Wind Environment Test*
- *-Topography Model Test*

▶ **Wind Tunnel Testing & Aerodynamic Analysis**

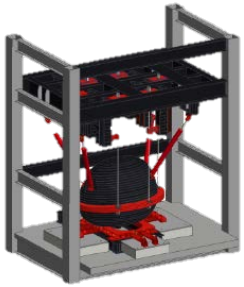
- *-Section Model Test*
- *-Full Bridge Model Test*
- *-Pylon Model Test*
- *-Buffeting Analysis*
- *-Flutter Analysis*

▶ **Analytics of Wind & Vibration**

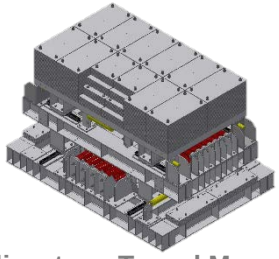
- *-Computer Wind Engineering*
- *-Force Vibration Test of Building*
- *-Force Vibration Test of Bridge*
- *-Dynamic Characteristics Analysis of the Structure*
- *-Wireless Smart Sensor Networks*

# Vibration
## Control Devices

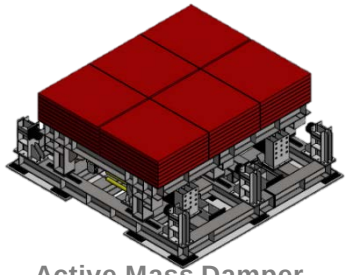
- Vibration Measurement: Measurement of structural frequency, damping ratio, and estimation of mode shape.
- Basic/Detail design : Determination of dimension, types, and specifications of tuned mass dampers, drawing works
- Fabrication/ Performance test at TESolution : Friction/vibration tests
- Installation/ Performance test at construction site : Frequency tuning and verification of required control performance
- Maintenance : Check control performance and main components



Pendulum-type Tuned Mass Damper



Sliding-type Tuned Mass Damper



Active Mass Damper

# Vibration
# Control Devices

## Application for Buildings

International organization for standard-ization (ISO) and building codes in many countries (such as AIJ2004, ISO 10134) recommend that structures meet specific criteria of vibration control classified by natural period of the building and human perception level of building acceleration. The objective of vibration control device is to improve damping efficiency and habitability of building by reducing the building acceleration with the installation of vibration control device.

**Songdo POSCO E&C Hezadquarter, Incheon, Korea, 2010**

- Tower A – 80T Sliding type TMD
- Tower B - 160 ton Sliding type TMD

**TechnoMart, Seoul, Korea, 2013**

- 50 ton Hybrid Mass Damper
  40 ton TMD for vertical vibration control
  50 ton AMD for horizontal vibration control

**Taichung Treasure Garden, Tachung, Taiwan, 2016**

- 150 ton Pendulum type Tuned Mass Damper

# Vibration
# Control Devices

## Application for Bridges

Long-span bridges, such as suspension or cable-stayed bridges are structurally highly vulnerable to wind load due to small bending / momentum stiffness and damping ratio. In case of footbridge, vibration serviceability may not be satisfied due to excessive vertical vibration through pedestrian movement even if the structural safety is satisfied.

Vibration control devices for bridges are installed not only to increase the wind resistant performance under construct-ion and in- service stages but also to improve serviceability of footbridges

Geoga Bridge (Korea)

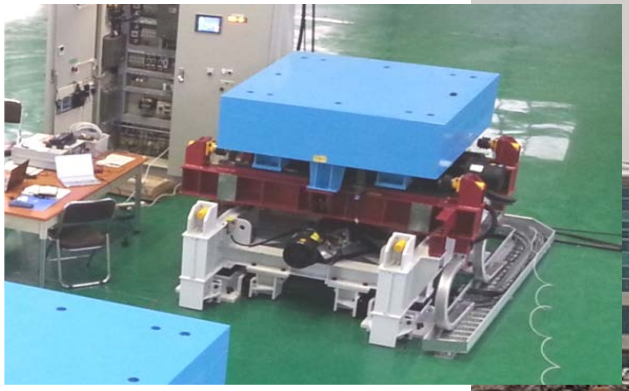
2nd Jindo Bridge (Korea)

# Vibration
# Control Devices

## Application for Special Structures

Vibration control devices can be designed in various shapes and sizes to fit in the tightest installation location to increase structural damping.

Namsan Cable Car (Korea)



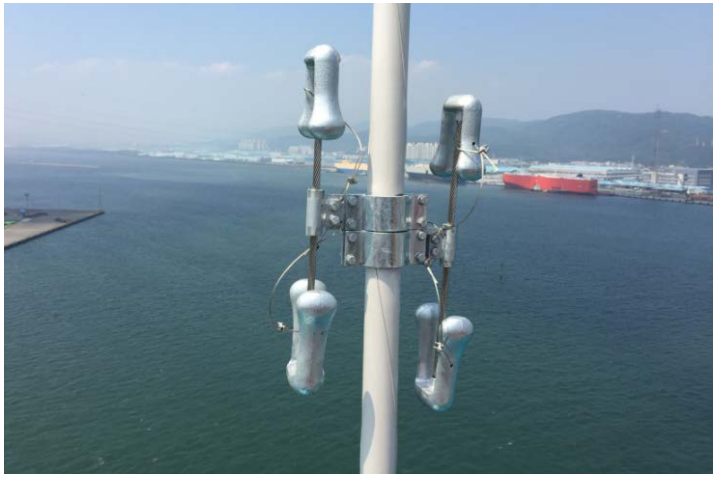
Incheon Internation Airport ATC Tower (Korea)

# Vibration
# Control Devices

## Stockbrdige Damper for Bridge Cables

Stockbridge damper, currently most commonly used vibration damper for power line, can be designed to dissipate the input wind energy over a wide range of frequencies

- Aeolian vibration (vortex-induced vibration)
- Galloping
- Wake galloping
- Rain- Wind induced vibration
- Parametric excitation
- Buffeting



Stockbridge Damper, Ulsan Bridge(suspension bridge), 2015

Stockbridge Damper, Palyung Bridge(suspension bridge), 2016

Stockbridge Damper, Palyung Bridge(` bridge), 2016

# Structure
## Aerodynamics

### High Frequency Force Balance Test (HFFB Test)

Major findings:

- Base sheer, base moment
- Static floor-by-floor wind load for structural design
- Wind-induced acceleration, serviceability evaluation (AIJ, ISO6897, ISO10137, NBCC, etc.)

Al Reem Island Four Vanes (UAE)

Busan IFC (Korea)

Soho Navi, Al Reem Island (UAE)

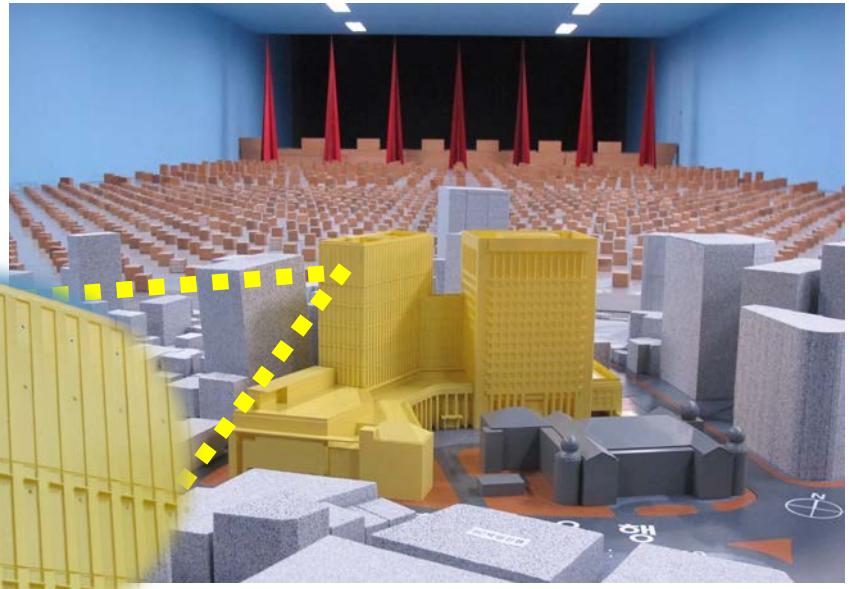
# Structure
## Aerodynamics

### Wind Pressure Test

Major findings:

- Pressure for cladding design
- Wind load for design of roof structures
- Wind pressure for design of structural member for open-air structures such as parapet, canopy, free-standing wall, etc.

Changwon Masan Baseball Stadium (Korea)



Headquarter of Bank of Korea (Korea)

# Structure
## Aerodynamics

### Aeroelastic Model Test

Major findings:

- Time dependent data of displacement, acceleration response
- Possibility of vortex-induced vibration or aerodynamic instability vibration
- The same findings to that of HFFB Test

Boryoung Power Plant Steel Stack (Korea)

Dangjin Steel Stack (Korea)

# Structure
## Aerodynamics

### Pedestrian-level Wind Environment Test

Major findings:

- Wind spend + wind direction occurrence frequency in relation to the climate data
- Wind speed ratio with respect to design wind speed
- Assessment of pedestrian level wind load
- Visualization of wind flow

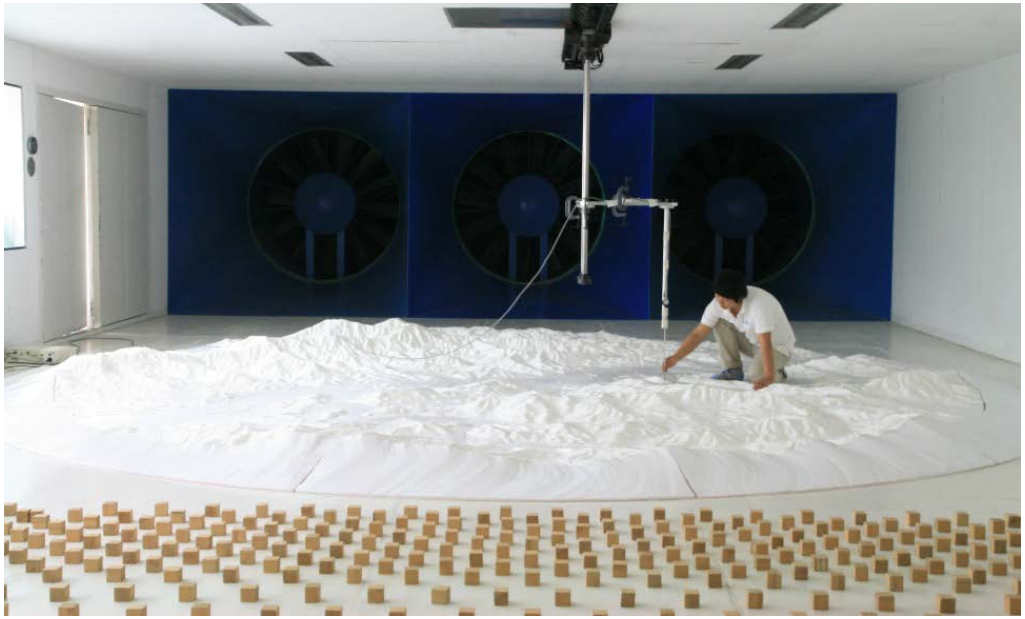
Boryoung Power Plant Steel Stack (Korea)

# Structure
## Aerodynamics

### Topography Model Test

Major findings:

- Distribution of wind speed (horizontal and vertical directions)
- Distribution of turbulence intensity (horizontal and vertical directions)
- Topographic effects



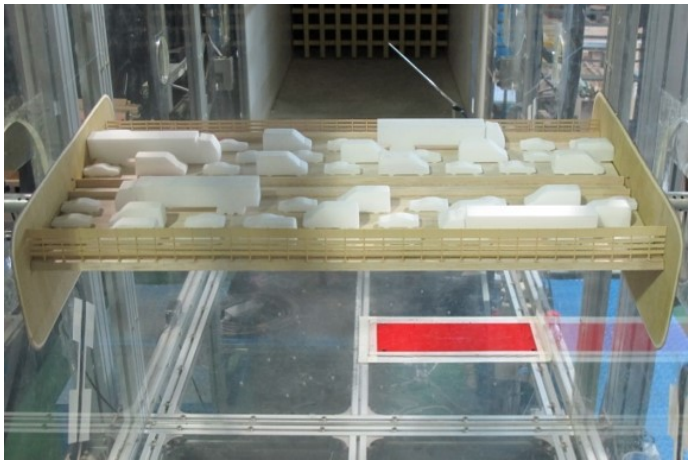
Everland Resort (Korea)

# Bridge Aerodynamics

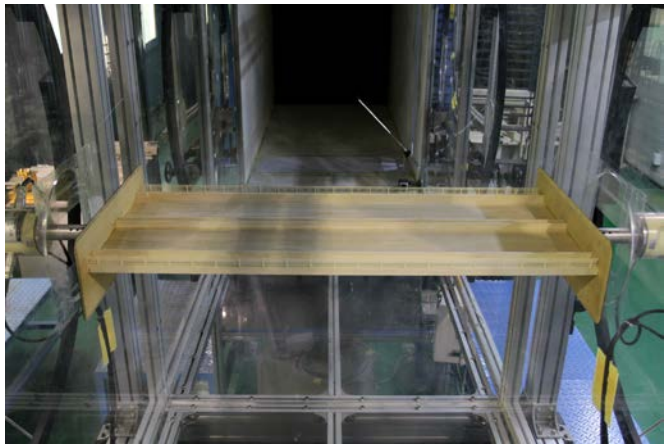
## Section Model Tests

Test areas:

- Aerodynamic stability: vortex-induced vibration, flutter, galloping
- Aerodynamic force drag, lift. moment coefficients
- Steady aerodynamic force: drag, lift, moment coefficients.
- Aerodynamic optimization of the shape for unstable aerodynamic behavior of bridge.

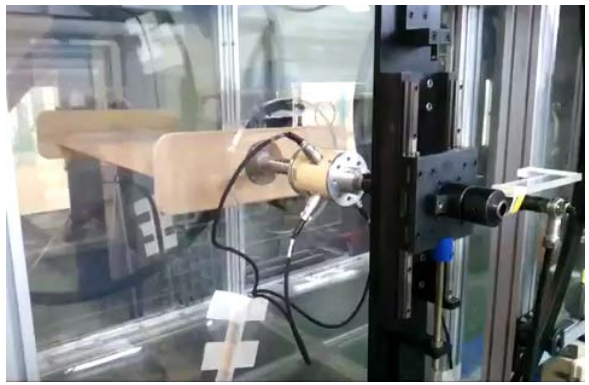


Mersey Gateway Bridge (UK)



New Nile Bridge (Uganda)

Spring Support System



Forced Oscillator

# Bridge Aerodynamics

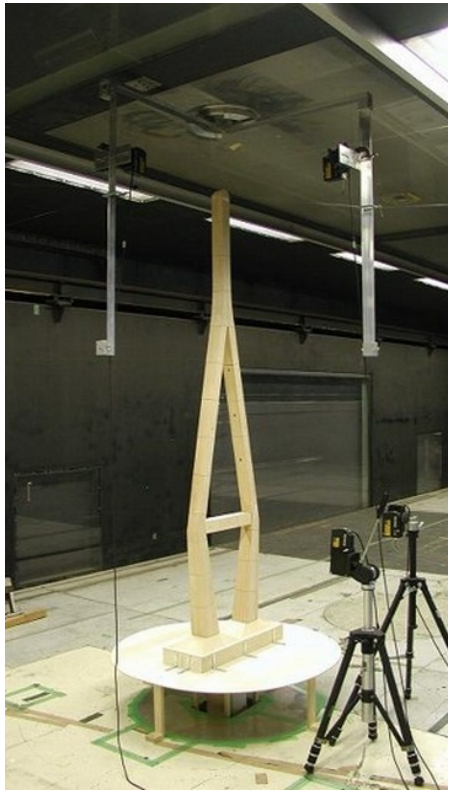
## Pylon Model Test

Test areas:

- Aerodynamic stability: vortex-induced vibration, flutter, galloping
- Base shear force, base overturning moment, base torsional moment
- Wind force of pylon legs: Drag, lift, pitching moment coefficients
- Wind force of whole pylon: Drag, lift, torsional moment, overturning moment coefficients
- Aerodynamic optimization of the shape of pylon leg to increase aerodynamic stability and to decrease static deformation due to wind

Vam Cong Birdge (Vietnam)


Chacao Channel Bridge (Chile)



Incheon Bridge (Korea)

# Bridge
# Aerodynamics

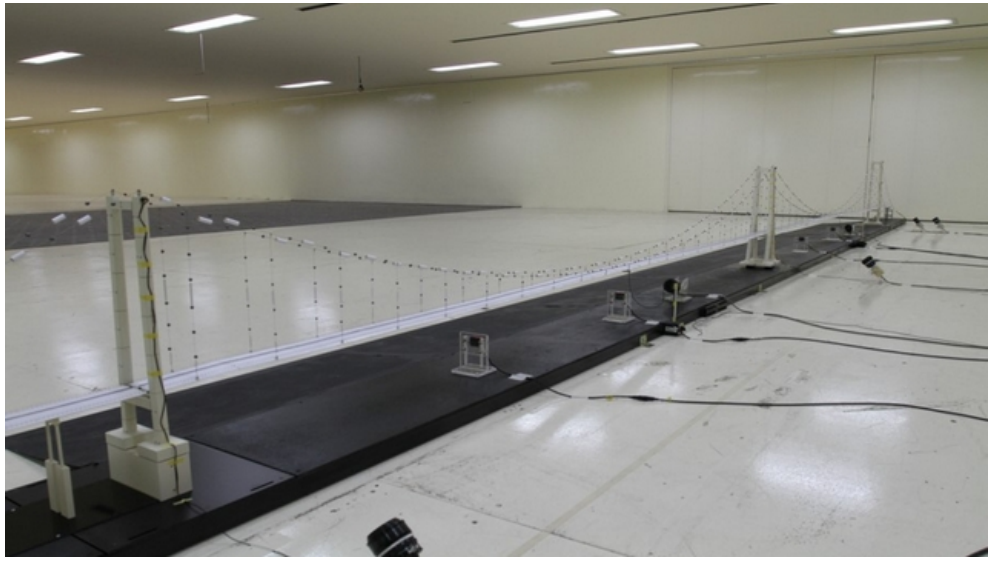
## Full Bridge Model Test

Test areas:

- Aerodynamic stability: vortex-induced vibration, flutter, galloping
- Aerodynamic stability of full-bridge in the erection / completed stage should be considered
- Aerodynamic stability of full bridge in various wind directions should be considered

(Effects from topography, construction facilities are considered)

Vam Cong Birdge (Vietnam)

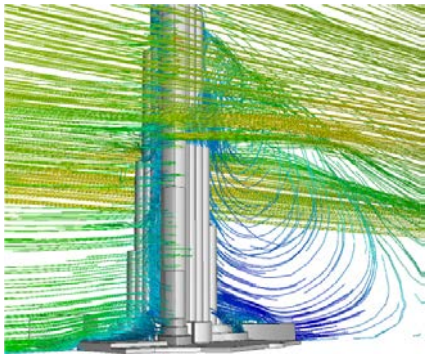


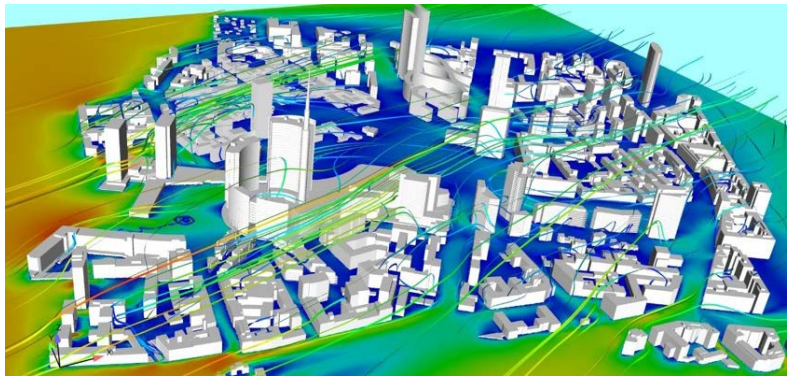
Chacao Channel Bridge (Chile)

# Analytics of Wind & Vibration

## Computational Wind Engineering

Computational Wind Engineering [CWE] uses Computational Fluid Dynamics [CFD) method to solve problems encountered in wind engineering. Numerical modeling with CFD can be a powerful alternative as it can avoid limitations of on-site measurements and wind tunnel tests.





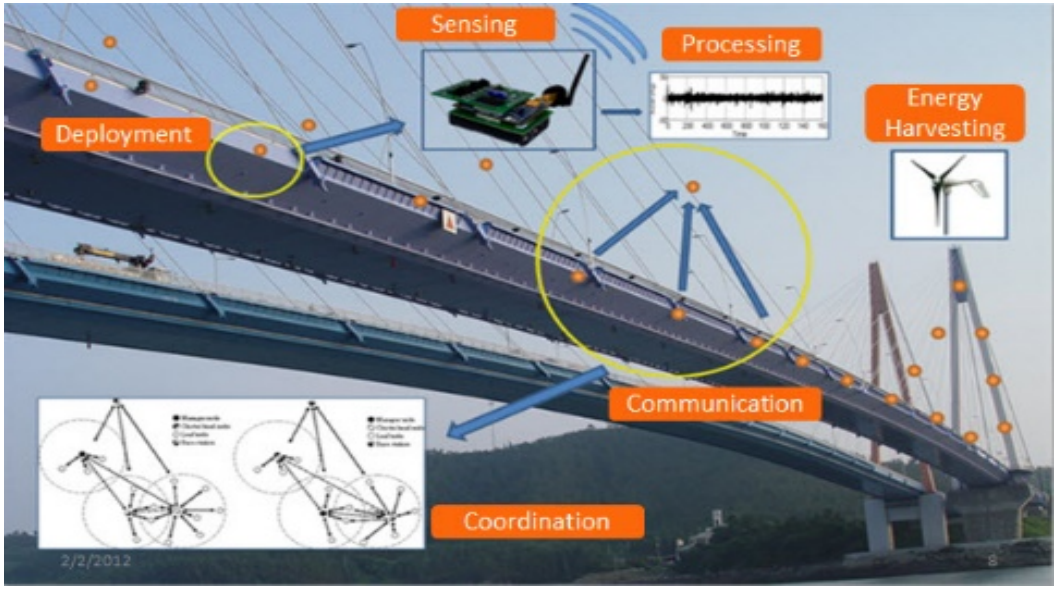
## Force Vibration Test on Structures

When evaluating dynamic safety of the structure such as wind resistance safety or anti-seismic safety, forced vibration test on structure with shake table can be conducted to effectively gather necessary data

# Analytics of Wind & Vibration

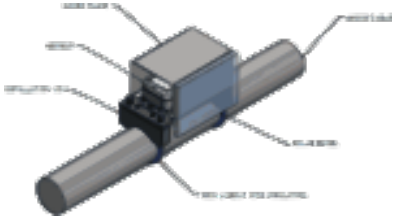
## Wireless Smart Sensors

Recent advancement in the sensor technologies have enabled Structural Health Monitoring(SHM) using wireless smart sensor networks (WSSNs), which is a promising alternative to the traditional wired SHM approaches. The smart sensors are typically small, inexpensive, and capable of wireless communication and onboard computation, addressing many of the concerns regarding wired monitoring.




**•Giant Observation Wheel under construction in Dubai (2016)**

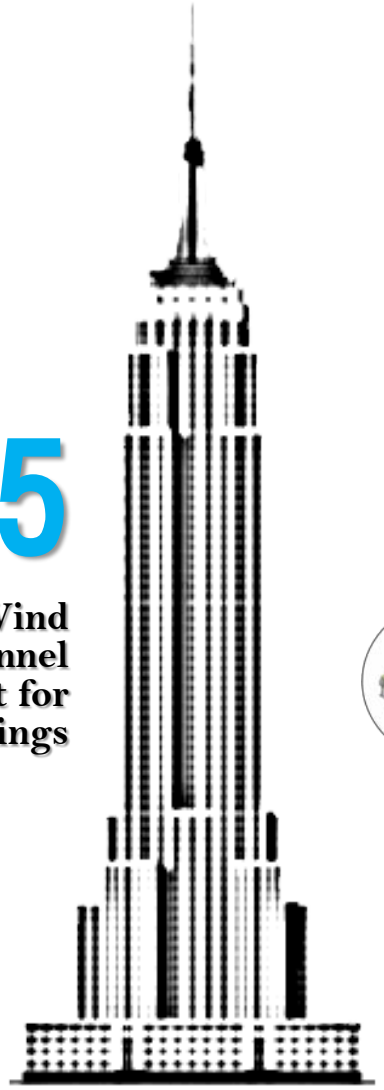
Wireless Smart Sensor



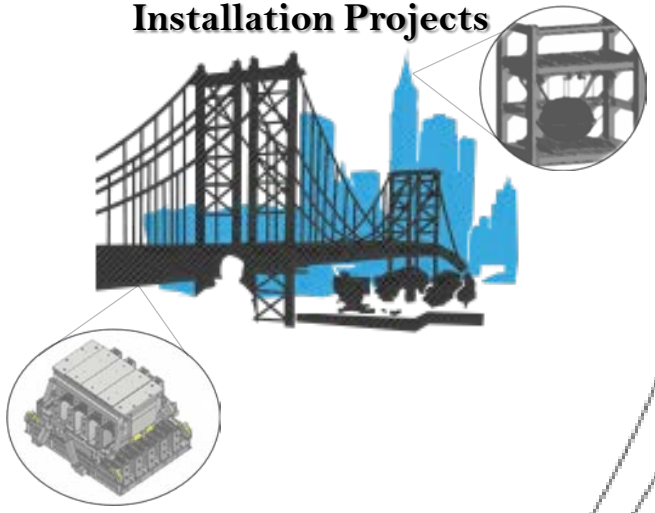
Wireless Smart Sensor on clamping system with solar panel

# Track Record

**285**
**Wind Tunnel Test for Buildings**

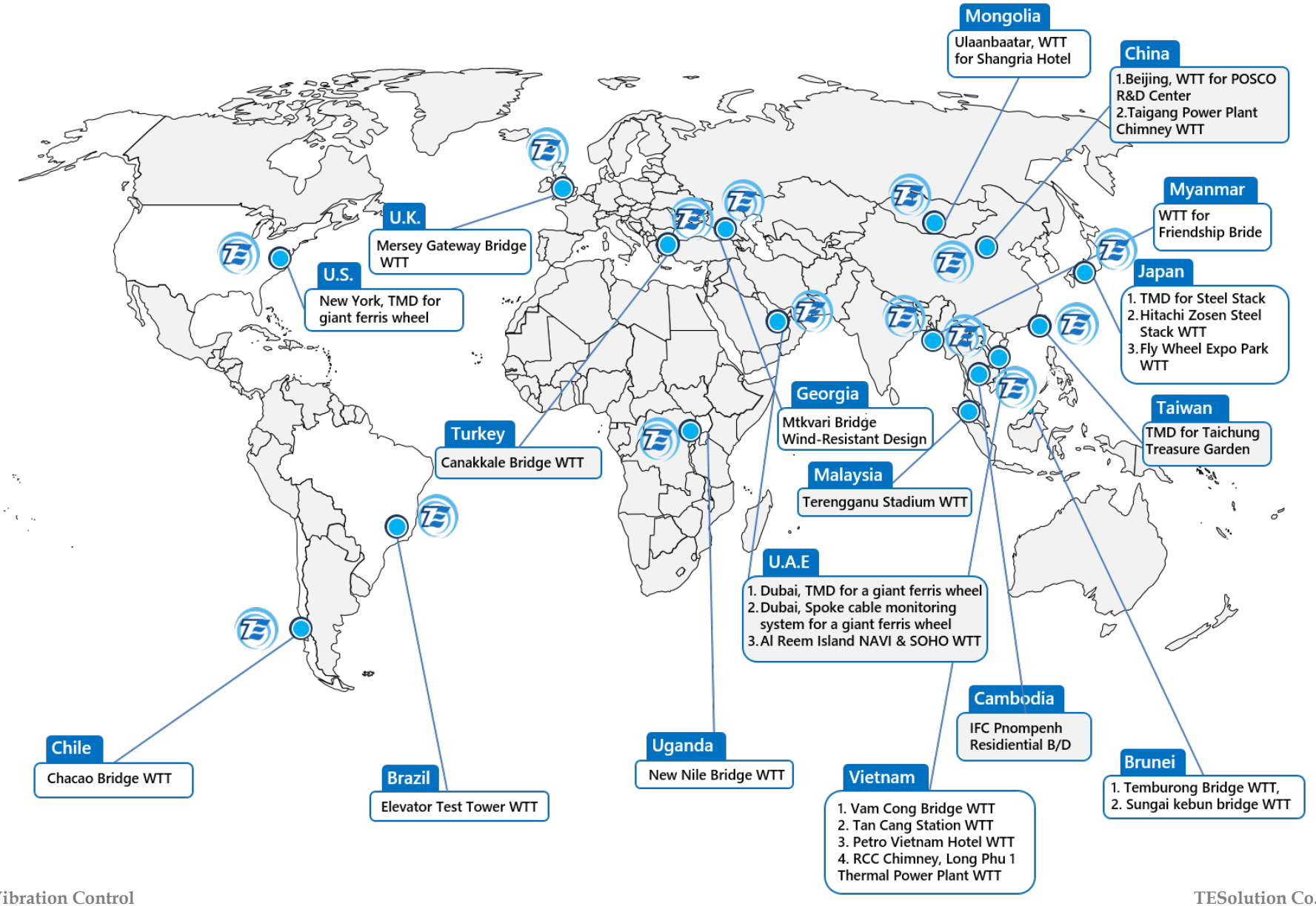


**39**
**Vibration Control Device Installation Projects**



**169**
**Wind Tunnel Test for Bridges**

# Global Presence



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