# 2025 Annual Seminar & Trade Show

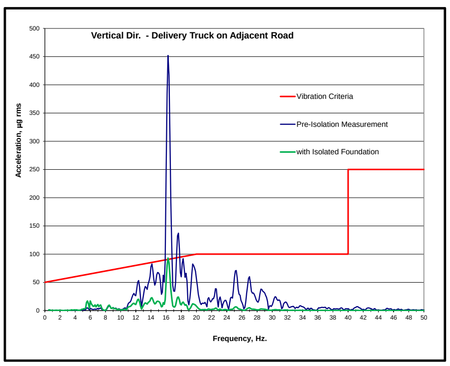
## Vibration and Control of Building Structures

Over the years, vibration serviceability has been a high-profile issue on projects like the Millennium Bridge in England and several stadium grandstands in Europe.  There are many less known vibration problems on office floors, monumental staircases and in manufacturing facilities throughout the U.S.  Locally in Minnesota, many MNSEA members have noticed footfall vibration on floors at the Mall of America, and there was a wind-induced vibration failure of the Martin Olav Sabo Suspension Bridge (Midtown Greenway).  This observed performance failures and MNSEA's strategic goal to advance technical knowledge are the motivation for this year's seminar topic.

**SESSION 1: Vibration Engineering and Active Vibration Control of Floors**
**Paul Reynolds, PhD: CEO of CALMFLOOR, Honorary Professor at University of Exeter, UK**

Innovative technologies for controlling building floor vibrations provide significant advantages over traditional methods throughout a building's lifecycle. Modern floor designs often prioritize vibration serviceability, and advanced vibration control solutions can reduce both construction costs and the carbon footprint of new buildings. For existing buildings, these technologies offer a cost-effective and non-disruptive way to resolve vibration issues without requiring extensive structural modifications. They also enable upgrades to accommodate more sensitive uses, such as converting office or commercial spaces into laboratories, healthcare facilities, or residential properties. This presentation offers a concise introduction to vibration engineering in buildings, focusing on the concept of active mass damping and its practical application to building floors. Several global case studies illustrate the successful deployment of this technology.


**SESSION 2 – Vibration Serviceability and Measurements:  Discussion, Demonstration, Case Studies.**
**Anthony J. Baxter, P.E., Principal at ESI Engineering**
**Peter G. Olney, P.E., Consulting Engineer at ESI Engineering**




Vibration serviceability refers to the ability of a structure to function as intended without causing annoyance to its occupants or compromising the performance of sensitive equipment.  It is an important design issue for buildings where human comfort is a priority, such as office buildings, hospitals, and residential structures.  It is critical for buildings with sensitive laboratories, operating rooms, and equipment, such as high magnification microscopes, MRIs, and microelectronic fabrication tools.  Understanding the vibration requirements is part of the challenge.  Analysis during design and measurements of vibration levels can also be challenging.  In this presentation, we will discuss the breadth of vibration serviceability, considerations for the structural engineer, measurements, and several project examples.

**SESSION 3 – Introduction to passive TMDs, base isolation of structures & industrial equipment.**
**Florian Sassmannshausen – Vice President, Building Acoustics at GERB Vibration Control Systems**

Tuned Mass Dampers (TMDs) and vibration isolators, though often hidden from view, play a crucial role in the performance of buildings and structures, impacting human comfort, acoustic comfort, or protecting vibration-sensitive equipment. Tuned mass dampers are essential for minimizing motion in tall and slender buildings, towers, long-span bridges, monumental staircases, and floors. Vibration isolators, on the other hand, protect vibration- or noise-sensitive spaces by reducing vibration transmission within mixed-use buildings, shield buildings from rail-induced vibration, or protect foundations and adjacencies from extreme vibrations from industrial equipment.
Established in 1908, GERB stands at the forefront of vibration control technology, offering tailored solutions for architectural, structural, and heavy industrial applications. This session will explore common challenges posed by vibrations in structures and delve into advanced engineering solutions that empower structural engineers in performance-based design, ensuring human comfort in buildings and structures.

# MNSEA

Minnesota Structural Engineers Association

## SEMINAR AND TRADE SHOW – MAY 13, 2025

### Paul Reynolds, PhD: CEO of CALMFLOOR, Honorary Professor at University of Exeter, UK

Paul Reynolds is the CEO of CALMFLOOR, a company dedicated to commercializing innovative Active Mass Damping (AMD) technology for controlling vibrations in building floors. Prior to this, he spent over 15 years as an academic at the Universities of Sheffield and Exeter, where he led pioneering research in vibration control and serviceability and published over 150 papers in this field. Paul has also been a trusted consultant to the industry, contributing to dynamic testing and monitoring projects, including several UK sports stadiums, and providing solutions for high-profile challenges such as the London Millennium Bridge vibration issue. He currently holds an Honorary Professorship at the University of Exeter.

### Anthony J. Baxter, P.E. – Principal at ESI Engineering

Tony Baxter has been principal at ESI Engineering since 2012. He has 36 years of experience, with 25 of those years at ESI, specializing in building and equipment vibration and noise control. Sensitive hospitals, labratories and microelectronics facilities are his speciality, including requirements for structural design. He has used modal analysis and other techniques to solve critical vibration related issues. His experience in vibration and noise analysis includes mechanical equipment vibration isolation, HVAC noise control, isolation system design, development of unique solutions, and troubleshooting. Tony has a passion for finding simple solutions to complex problems. He has published papers on Tuned Mass Dampers to control vibration in buildings and on predicting ground vibration from equipment foundations. Tony has a B.S. degree in Mechanical Engineering from Iowa State.

### Peter G. Olney, P.E. – Consulting Engineer at ESI Engineering

Peter Olney joined ESI in the Summer of 2021 and serves as a Consulting Engineer in Structural Dynamics and Design. Peter holds a B.S. degree in Civil Engineering from the Illinois Institute of Technology in Chicago, IL. He has a M.S. degree in Natural Hazards and Risks in Structural Engineering from the Bauhaus-Universität Weimar in Germany where he also was a research associate for GRK 1462: Evaluation of Coupled Numerical and Experimental Partial Models in Structural Engineering. As part of the research group, Peter presented conference papers around the world related to the design of monitoring systems for structures. Peter has experience with vibration measurement systems, as well as design of building and industrial structures. He is a licensed civil engineer in Minnesota and Oregon.

### Florian Sassmannshausen – Vice President, Building Acoustics at GERB Vibration Control Systems, Inc.

Florian is the Vice President at GERB Vibration Control Systems and specializes in building vibration and acoustics. With 15 years of experience, he has successfully overseen the design and implementation of vibration mitigation solutions across a broad spectrum of global projects. Florian's expertise allows him to approach complex, technically demanding challenges with innovative, out-of-the-box thinking. Typical projects encompass building base vibration isolation, floating floors to protect vibration-sensitive areas, noise mitigation in mixed-use developments, discrete isolation of beams and columns, and the retrofitting of existing structures, rooftop helipads, and buildings.

"It's all springs and dampers," – but with the unique challenge to balance structural integrity with minimal displacement, while delivering exceptional isolation performance through elasticity – two seemingly opposing objectives. Collaborating with a talented team of structural, civil, and mechanical engineers at GERB, Florian helps drive forward the company's legacy. Founded in 1908 in Berlin, GERB is a world-renowned leader in vibration isolation and vibration control engineering and manufacturing.

# Vibration Control

Made in Germany. Since 1908. Worldwide.

## Introduction to Passive Tuned Mass Dampers (TMDs), Vibration Isolation of Buildings & Structures, and Industrial Equipment

May 13, 2025
Florian Sassmannshausen
Florian@gerbusa.com



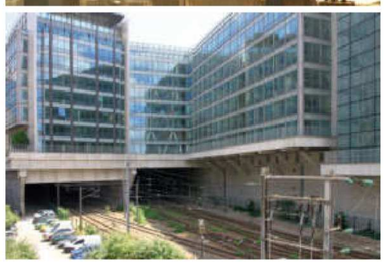
## Applications and Criteria



» **Control of Human-Induced Vibration**
for pedestrian bridges, stairs and floors comfort criteria is available from various resources, e.g. AISC Design Guide 11

» **Control of Wind-Induced Vibration**
for tall & slender towers, comfort criteria are available from ISO10137, and assessment from wind lab for 1-year and 10-year wind events, respectively.

» **Isolation of Buildings and Structures from Noise & Vibration**
Vibration isolation is typically based on an Environmental Impact Study, Federal Transit Administration recommendations, Vibration Criterion (VC-C, VC-D, etc.) for sensitive equipment, and others.



# GERB History

1908 Founded by William Gerb in Berlin, Germany
1967 First large turbine isolation in a nuclear power plant
1985 First vibration isolation for a building
1987 First Tuned Mass Damper TMD for a tall building
1989 First rail track isolation
1998 First spring-mass-system for a high-speed track
2005 Largest Turbine worldwide on spring support
2018 NOVODAMP® Polyurethane Bearings
2025 NYC Retrofit Building Base Isolation




# Application Sectors

» Manufacturing, Industry & Energy

» Architecture & Construction

» Transportation & Infrastructure

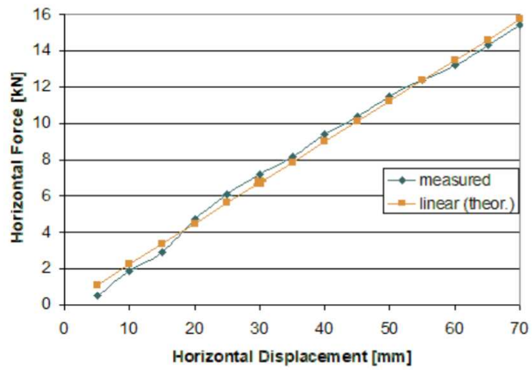
- » Shock & Vibration Isolation
- » Earthquake/Seismic Protection
- » Pipework Dampers

- » Noise & Vibration Isolation
- » Tuned-Mass Dampers
- » Retrofitting

- » Stiffness Transition Zones
- » Floating Slab Tracks
- » Services & Consulting

# GERB Helical Steel Springs

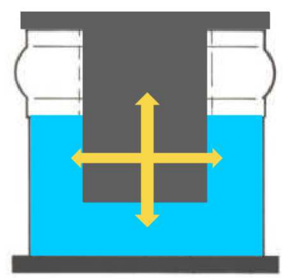
- Linear Load-Deflection Curve
- Static = Dynamic Characteristics
- High Load Capacities
- High Elasticity = High Isolation Efficiency
- Spring Cons

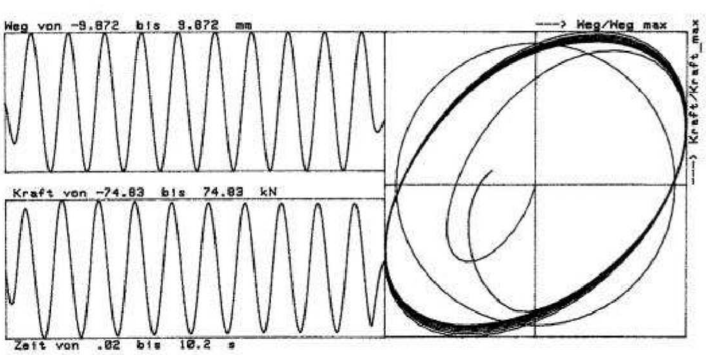





# GERB Viscodamper®

- High Damping Forces
- Determination of Damping Resistance in all Spatial Directions
- High Velocity-Proportionality






# Tuned Mass Dampers (Floors, Structures)

GERB

## Applications and Criteria

GERB

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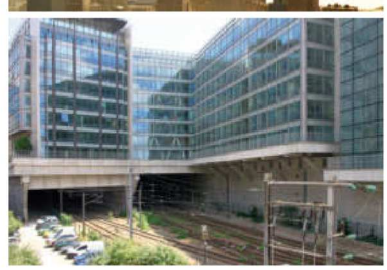


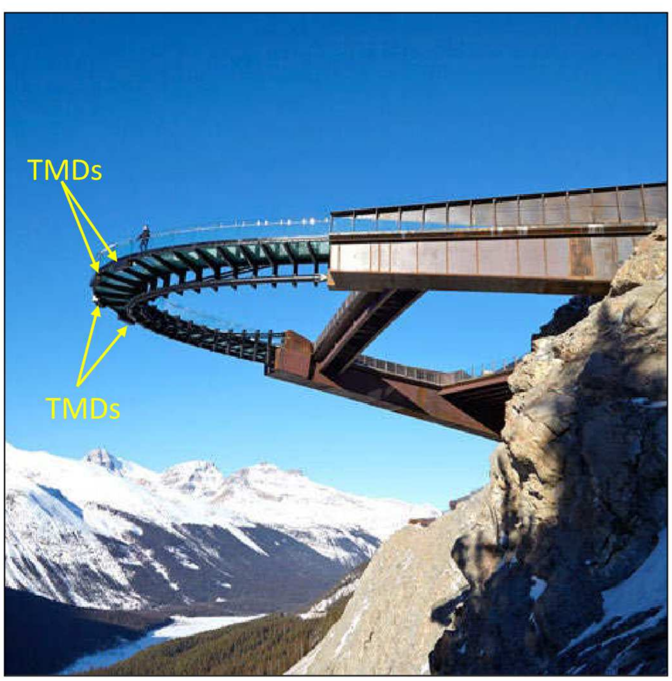
# GERB Vibration Control: Supplemental Damping

Light weight bridge

Light weight bridge with TMD

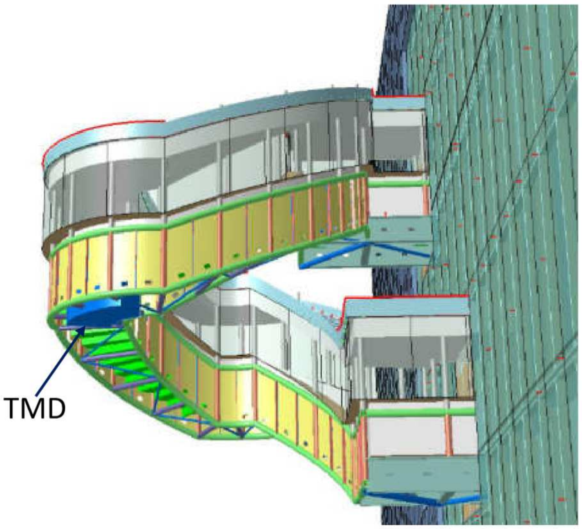

# GERB Vibration Control: Cantilevered Structures

Glacier Skywalk, Jasper National Park, AB




# GERB Vibration Control: Monumental Stairs

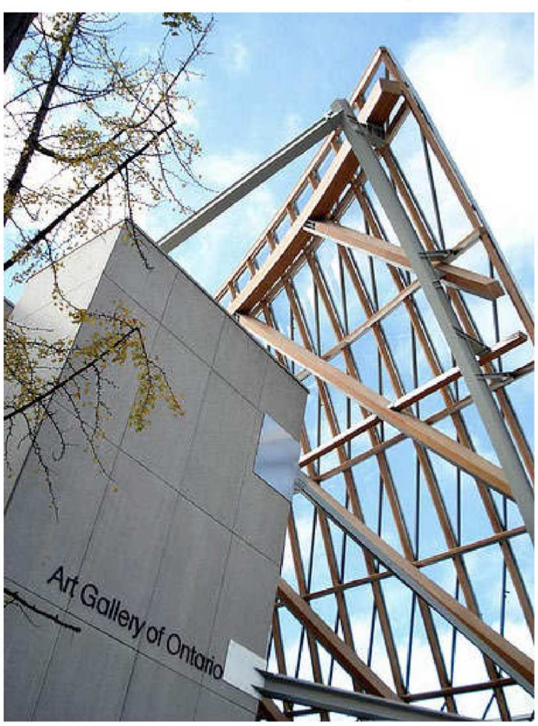
Art Gallery of Ontario





# GERB Vibration Control: Floors

Art Gallery of Ontario



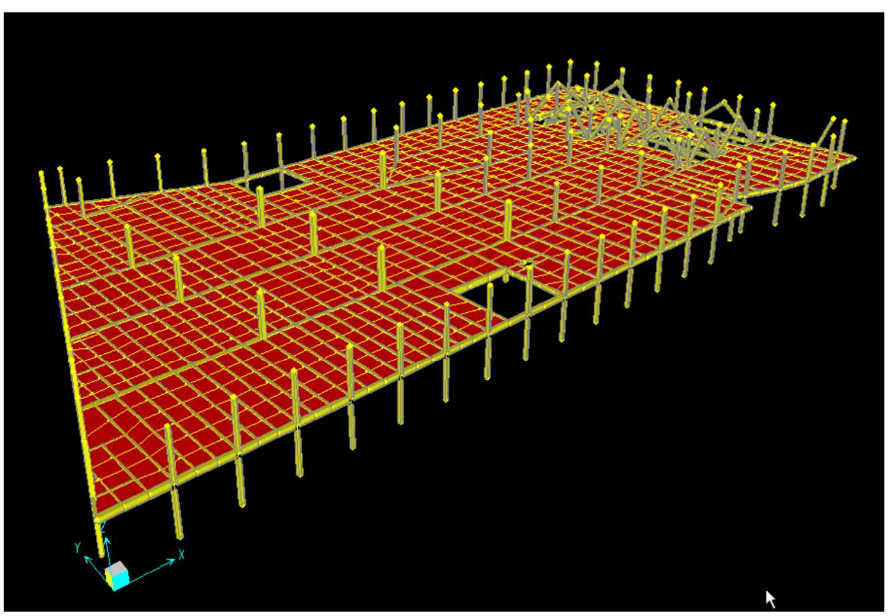

# GERB Vibration Control: Floors

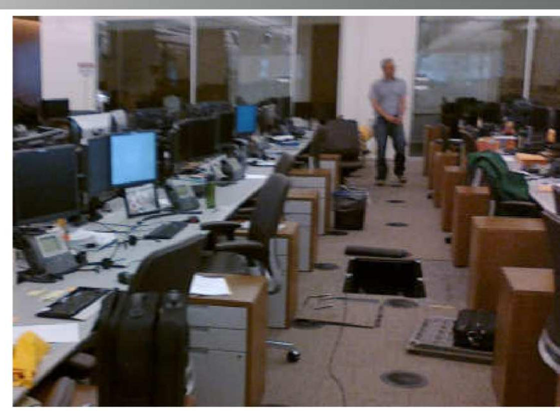
Art Gallery of Ontario



# GERB Vibration Control: Office Retrofit

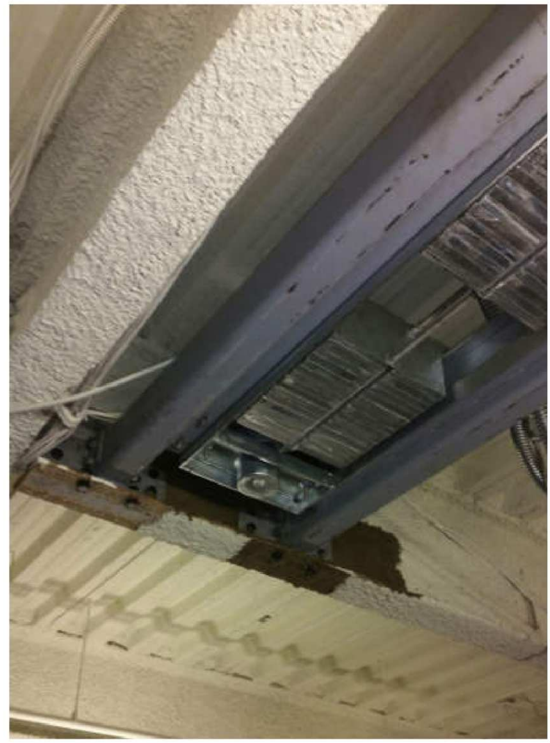
Open Office Floor, NYC



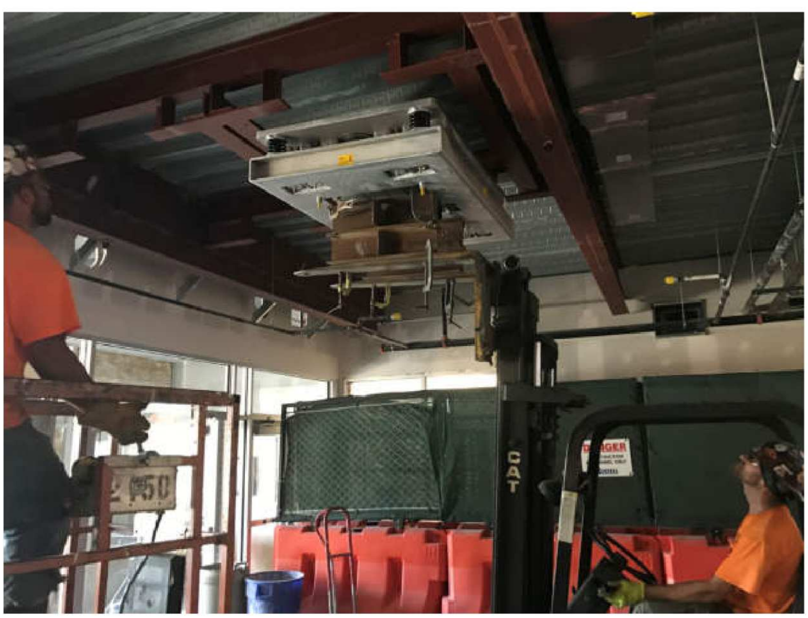


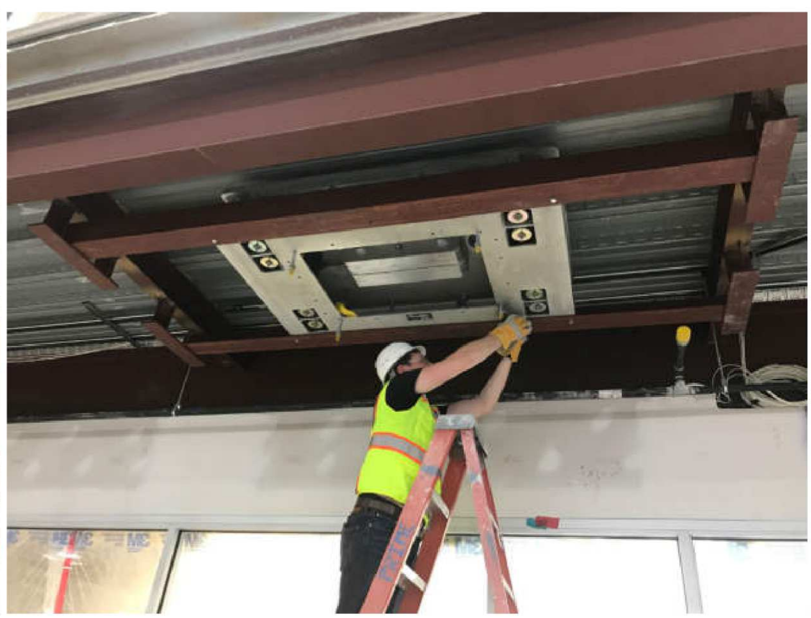
# GERB Vibration Control: Floors (retrofit)

Newly installed Gym Office Vibration, Boston

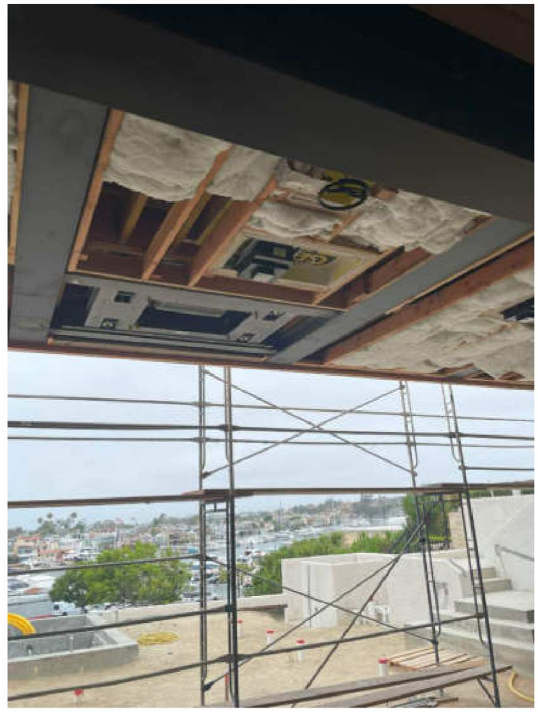


# Installation and Commissioning





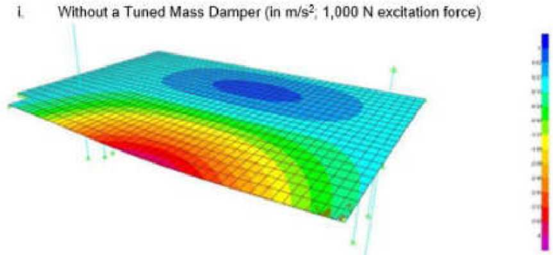
# Residential Floor and Balcony Vibration



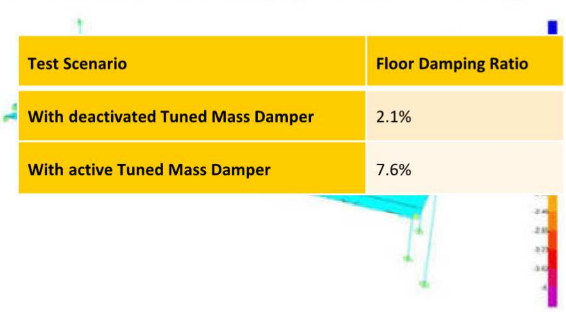
# Residential Floor and Balcony Vibration

**B. Acceleration: Mode 0 – Theoretical Values**

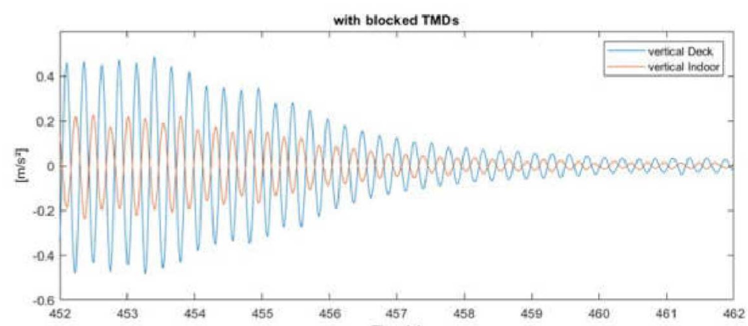
i. Without a Tuned Mass Damper (in $m/s^2$; 1,000 N excitation force)

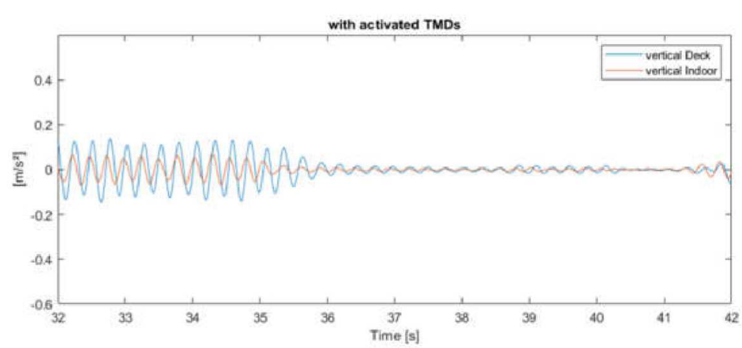


ii. With a 500 kg Tuned Mass Damper (in $m/s^2$; 1,000 N excitation force)



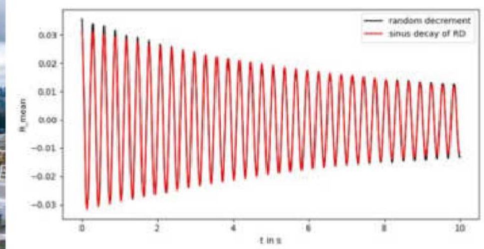
| Test Scenario | Floor Damping Ratio |
|---|---|
| With deactivated Tuned Mass Damper | 2.1% |
| With active Tuned Mass Damper | 7.6% |

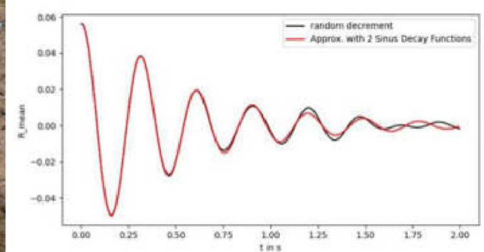


# GERB Vibration Control: Cantilevered Structures

Totem Lake Bridge - Kirkland, Washington

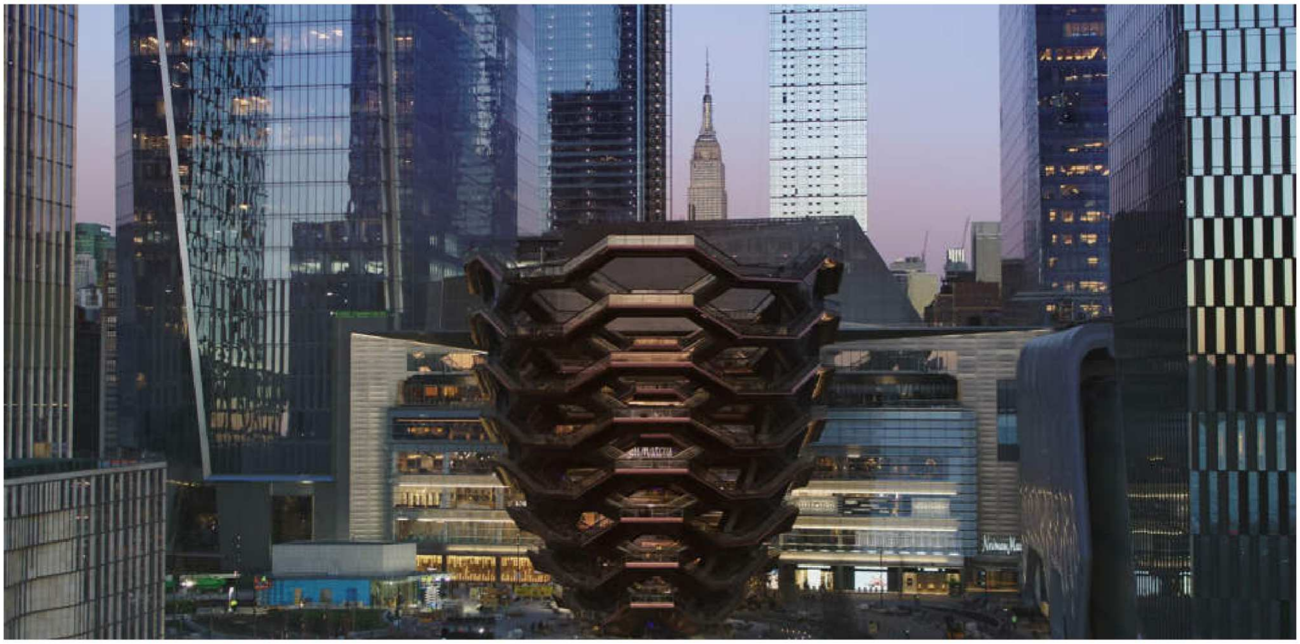




# Vibration Control: Grand Quay Observation Tower-Montreal

## The Vessel, Hudson Yards

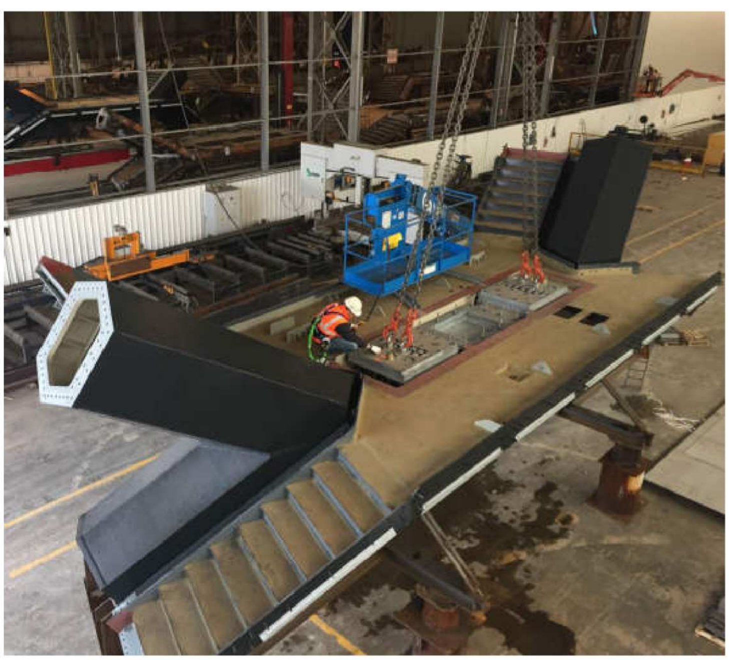
10 x 26,000 lbs. GERB TMDs for Vertical Footfall Induced Vibration

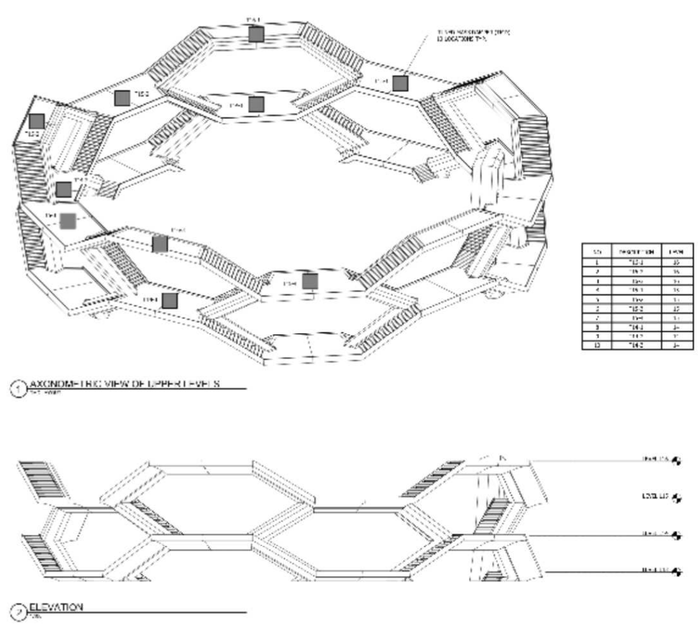




## The Vessel, Hudson Yards

10 x 26,000 lbs. GERB TMDs for Vertical Footfall Induced Vibration





# Applications and Criteria

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» **Control of Wind-Induced Vibration**
for tall & slender towers, comfort criteria are available from ISO10137, and assessment from wind lab for 1-year and 10-year wind events, respectively.

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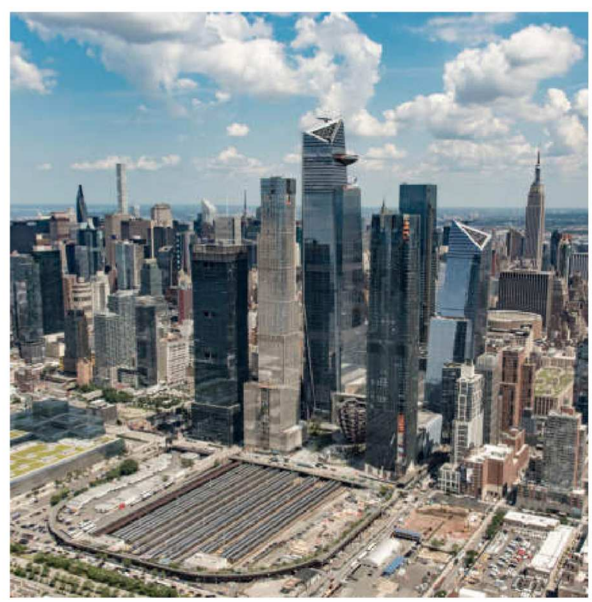
Vibration isolation is typically based on an Environmental Impact Study, Federal Transit Administration recommendations, Vibration Criterion (VC-C, VC-D, etc.) for sensitive equipment, and others.



# Vibration Control: GERB TMDs in Towers

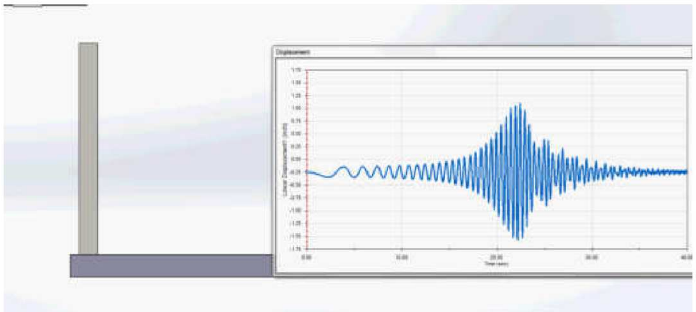
New York City Towers (excerpt)

- 50 West – 80 T single-axis rail system
- 45 E $22^{nd}$ – 600 T single pendulum
- 53 W $53^{rd}$ (MoMA Tower) – 450 T double pendulum
- 30 Hudson Yards – 650 T single pendulum
- 35 Hudson Yards – 220 T double pendulum
- 125 Greenwich – 2 x 100 T single-axis rail system
- 430 E $58^{th}$ – 3 x 230 T (690 T) dual-axis rail system
- 520 Fifth Avenue – 450 T single Pendulum TMD
- 262 Fifth Avenue – 265 T dual-axis rail system
- 8 Carlisle – 500 T Single Pendulum TMD - Design

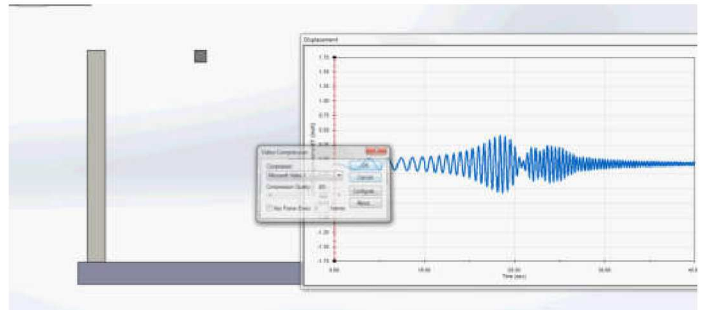


# GERB Vibration Control: Supplemental Damping

Cantilevered structure

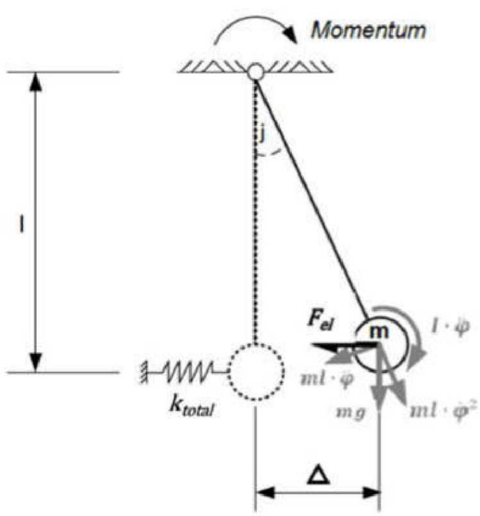


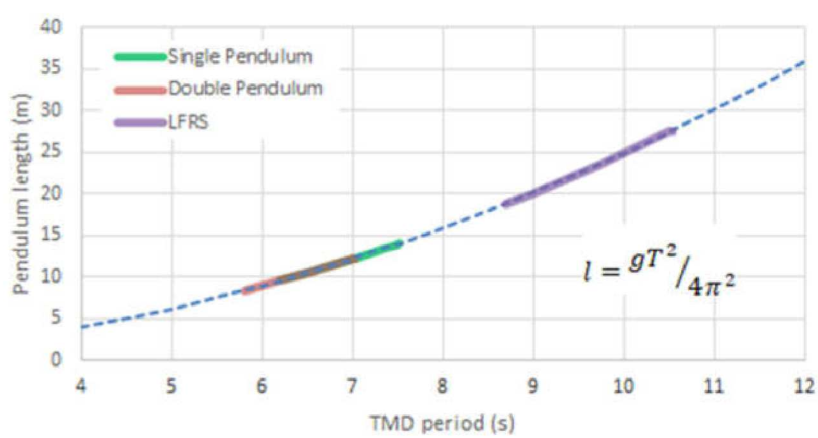
Cantilevered structure with TMD



# Vibration Control: GERB TMDs in Towers

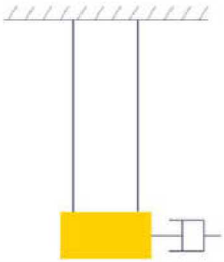
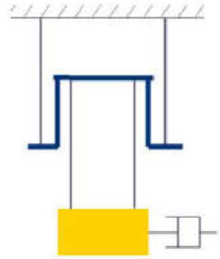
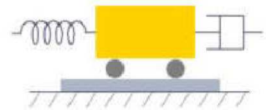
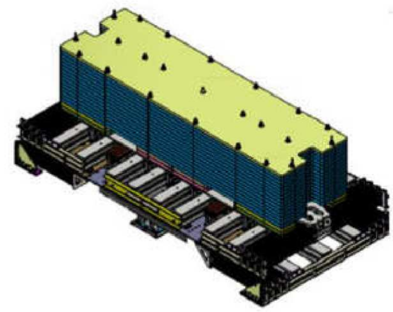
Pendulum Tuned mass damper



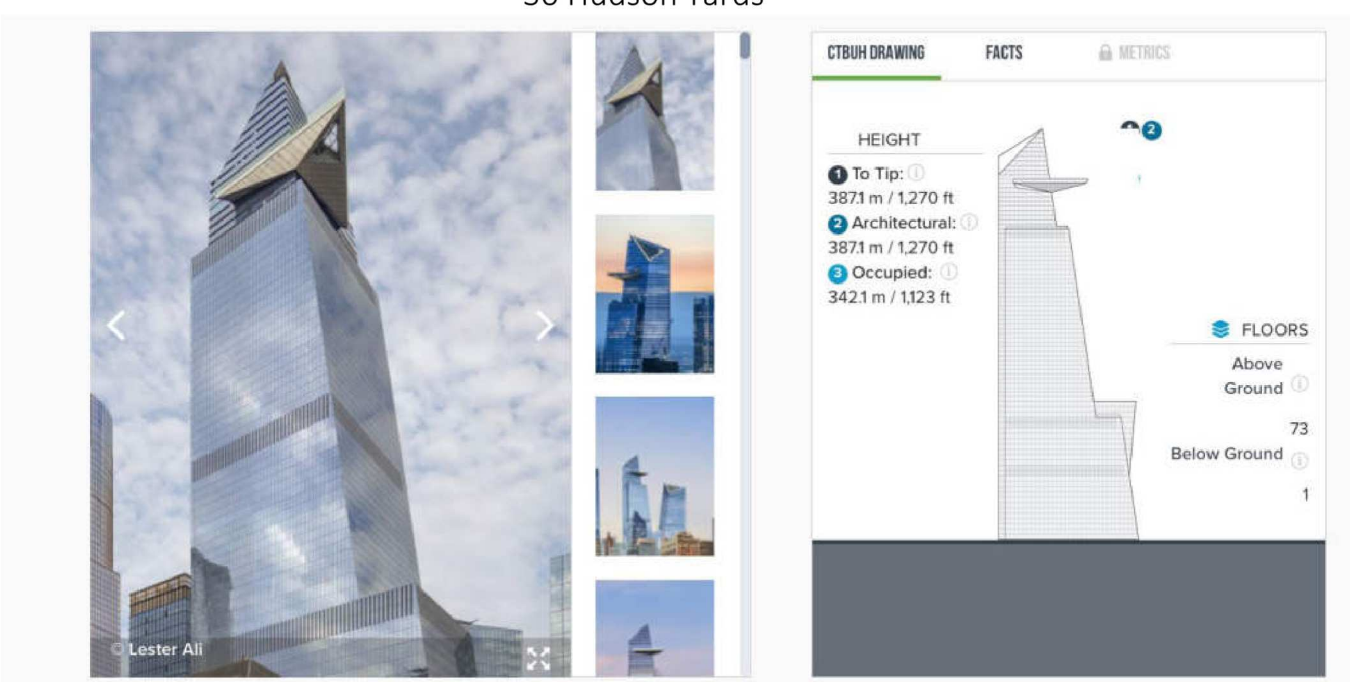
# Vibration Control: GERB TMDs in Towers

**Table 1b.** Example GERB TMD Implementations

| | TMD Type | | |
|---|---|---|---|
| | Single Pendulum | Double Pendulum | Low Friction Rail System (LFRS™) |
| Schematic |  |  |  |
| Example Rendering |  |  |  |

# Vibration Control: GERB Single Pendulum TMDs

30 Hudson Yards



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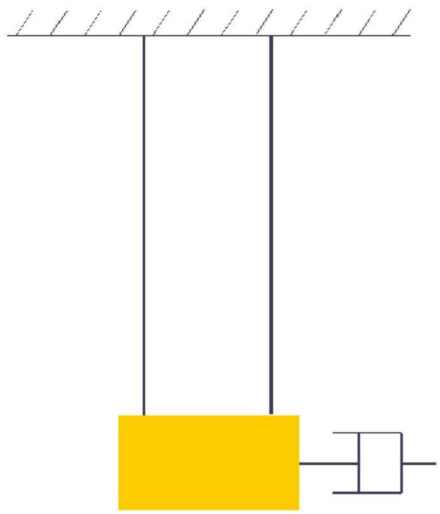
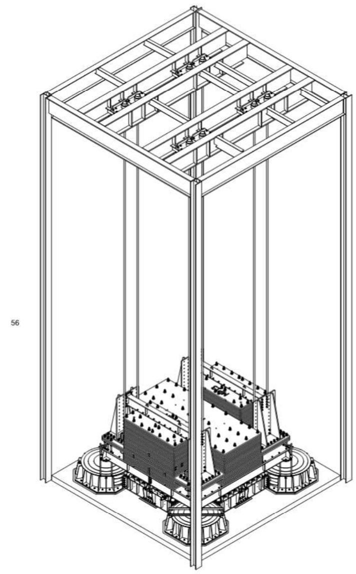
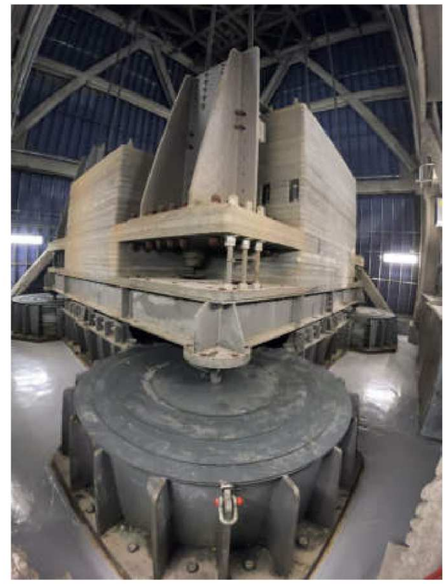






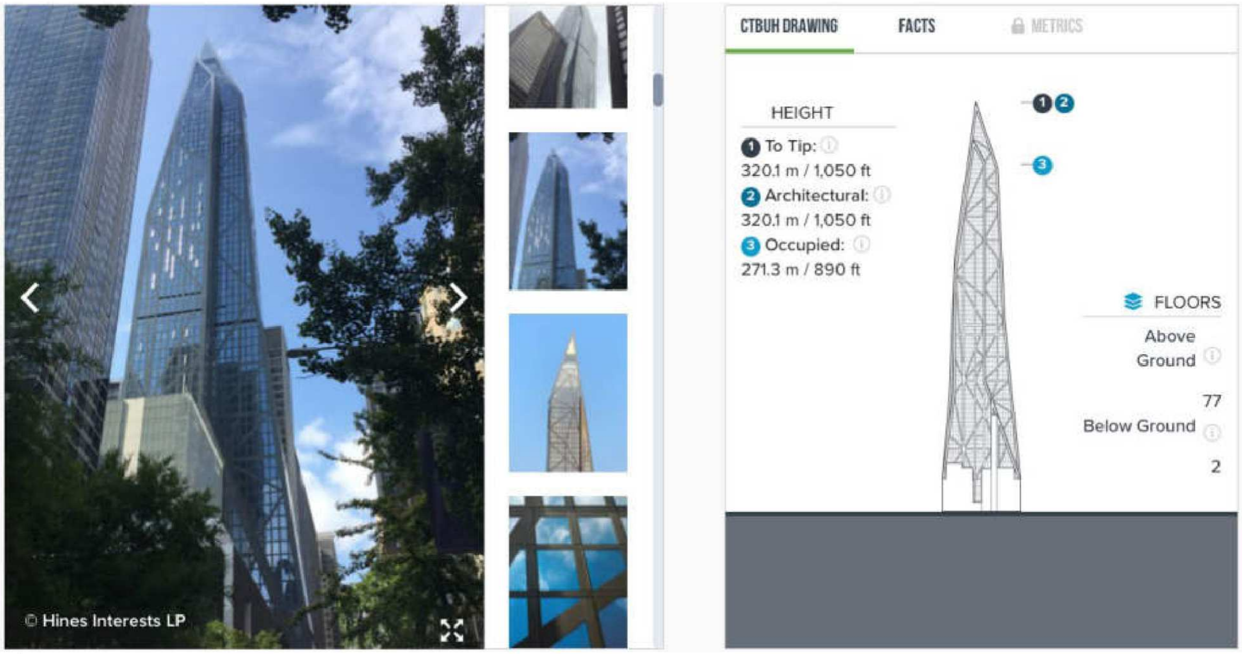


# Vibration Control: GERB Single Pendulum TMDs

30 Hudson Yards


# Vibration Control: GERB Double Pendulum TMDs

53 W 53rd Street (MOMA Tower)

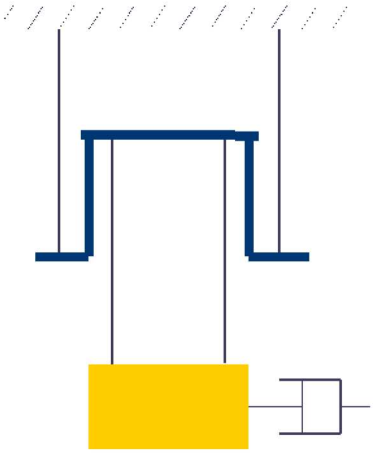





# Vibration Control: GERB Double Pendulum TMDs

# Vibration Control: GERB Double Pendulum TMDs

35 Hudson Yards





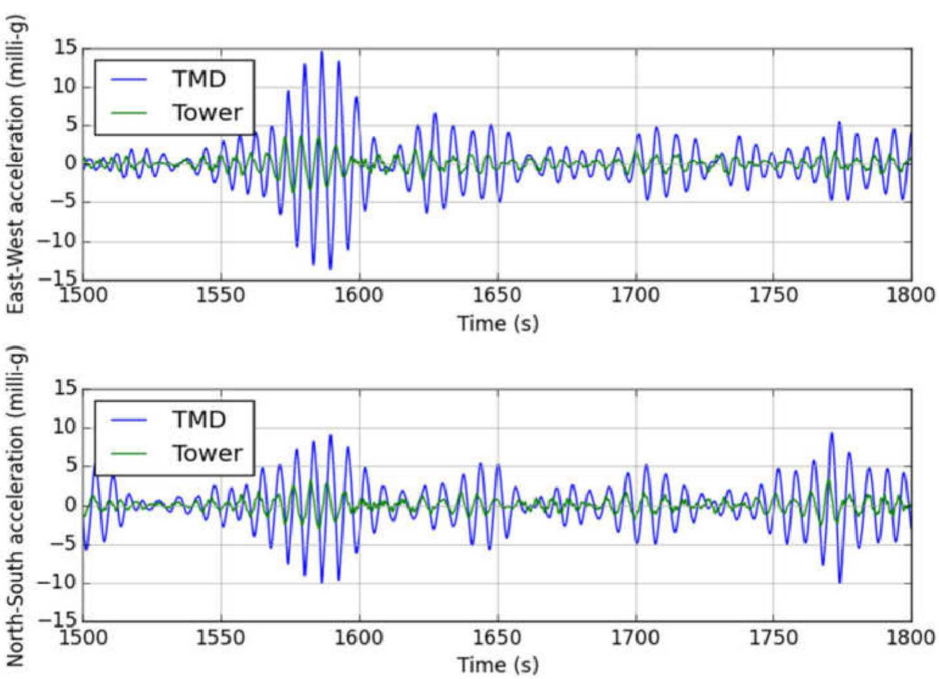
# 58 Sutton Place NYC, USA | 2020


**Vibration Source:**
Wind Induced Vibrations
**Tuning Frequency:**
0.1 Hz bi-directional
**Effective TMD Mass:**
3 x 220 t
**GERB Elements:**
Tuned Mass Damper

# Vibration Control: GERB LFRS 700 t TMD

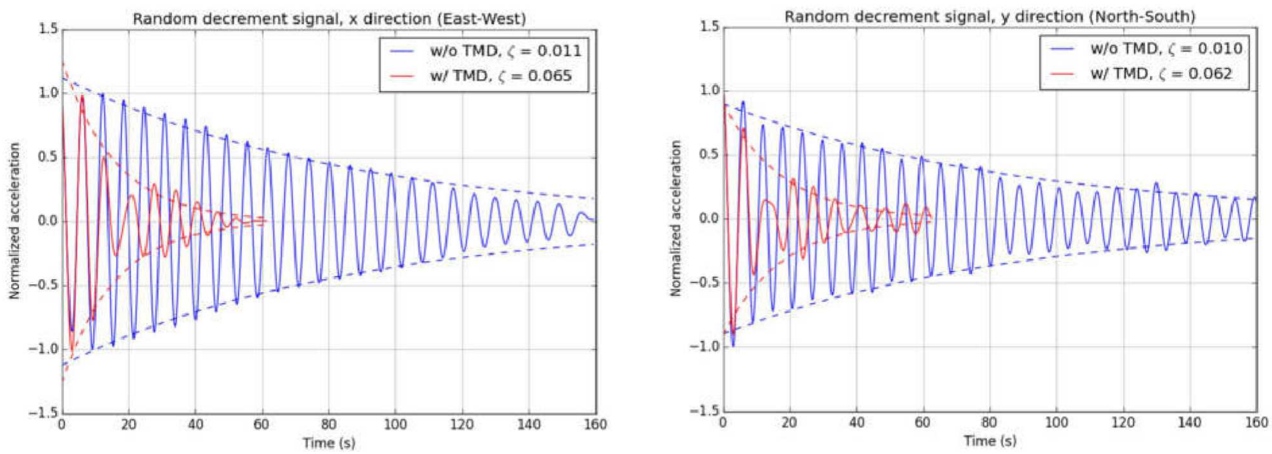


# TMD design examples: 45 E 22nd Street
(outdoor TMD)



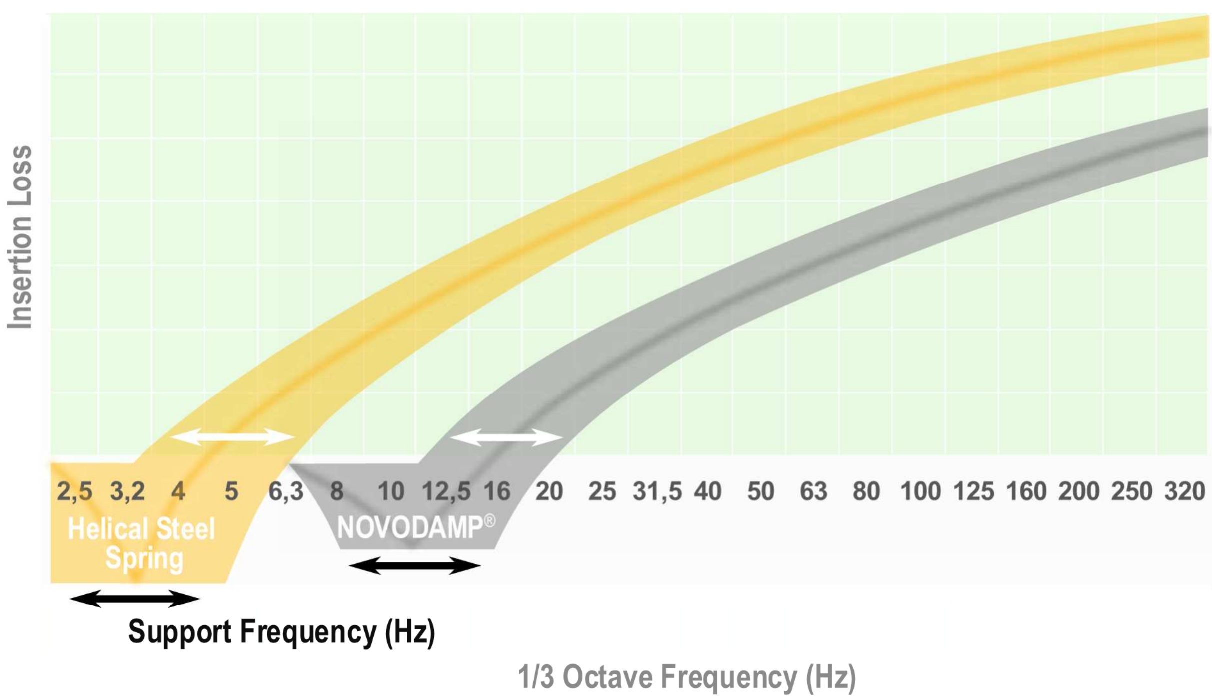
# TMD design examples: 45 E 22nd Street
(outdoor TMD)

Vibration Control: TMDs in Towers
Increase in Structural Damping!






# Elastic Decoupling



# Vibration Control – Damping Elements

**VISCODAMPER®:**

- High damping forces
- High velocity-proportionality
- Damping resistance in all spatial directions

- **Sordino Damping**

- **Coil-Resonance Damping System (CRDS)**
- **Noise Stop pads**



# Building Base Isolation

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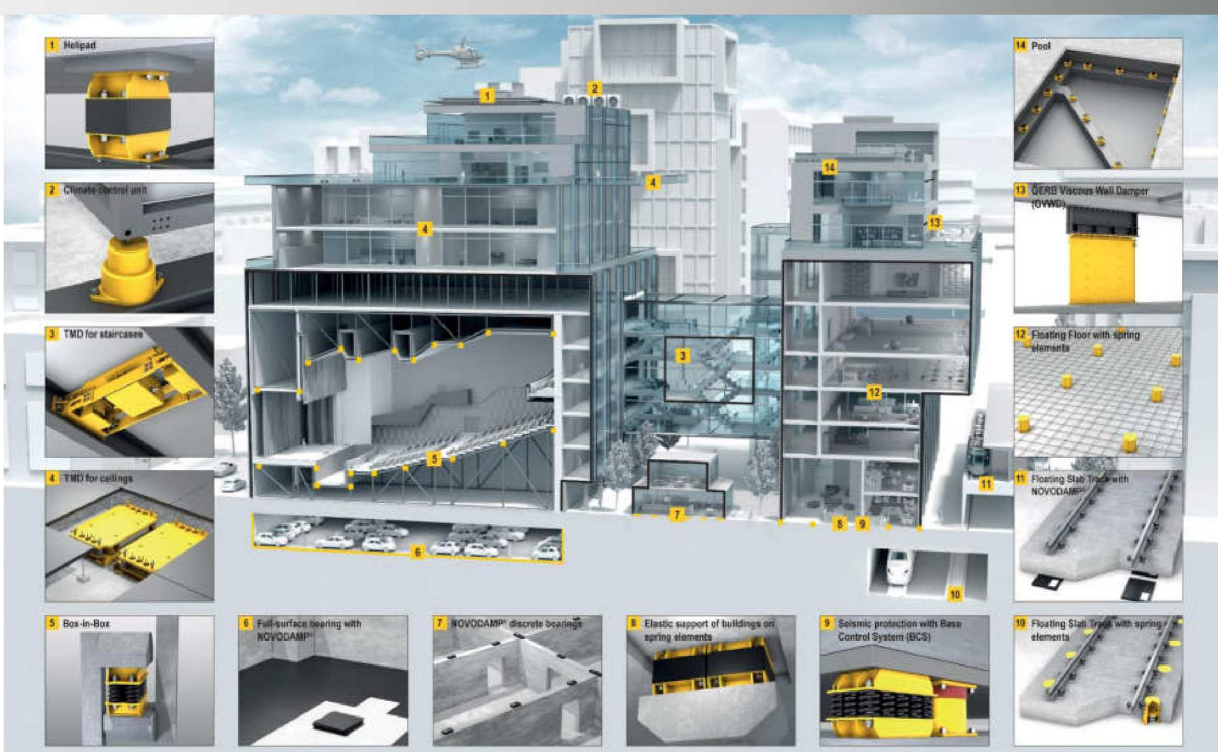
» **Isolation of Buildings and Structures from Noise & Vibration**
Vibration isolation is typically based on an Environmental Impact Study, Federal Transit Administration recommendations, Vibration Criterion (VC-C, VC-D, etc.) for sensitive equipment, and others.





# Disney New York City (7 Hudson Square)



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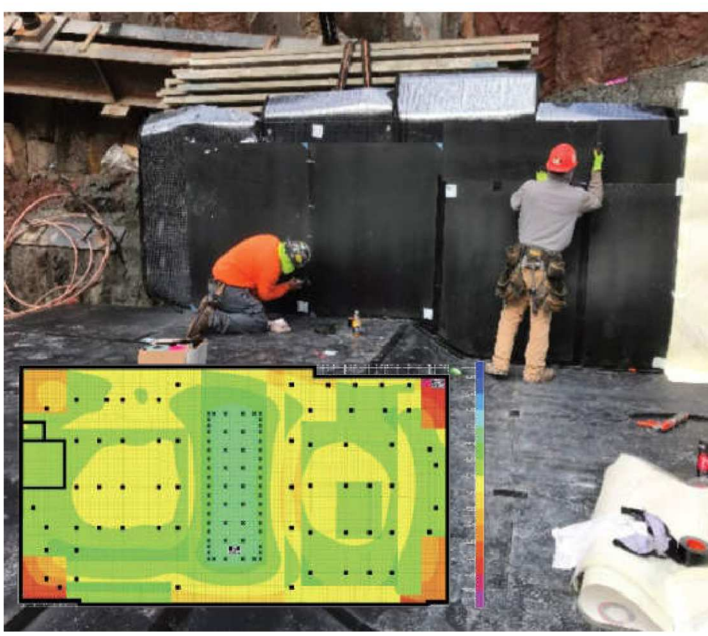
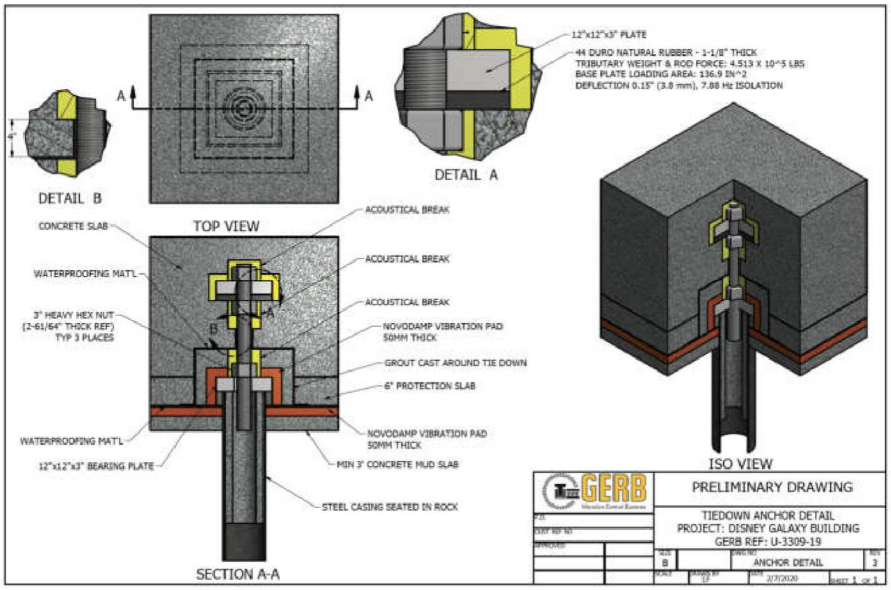


# Disney New York City (7 Hudson Square)

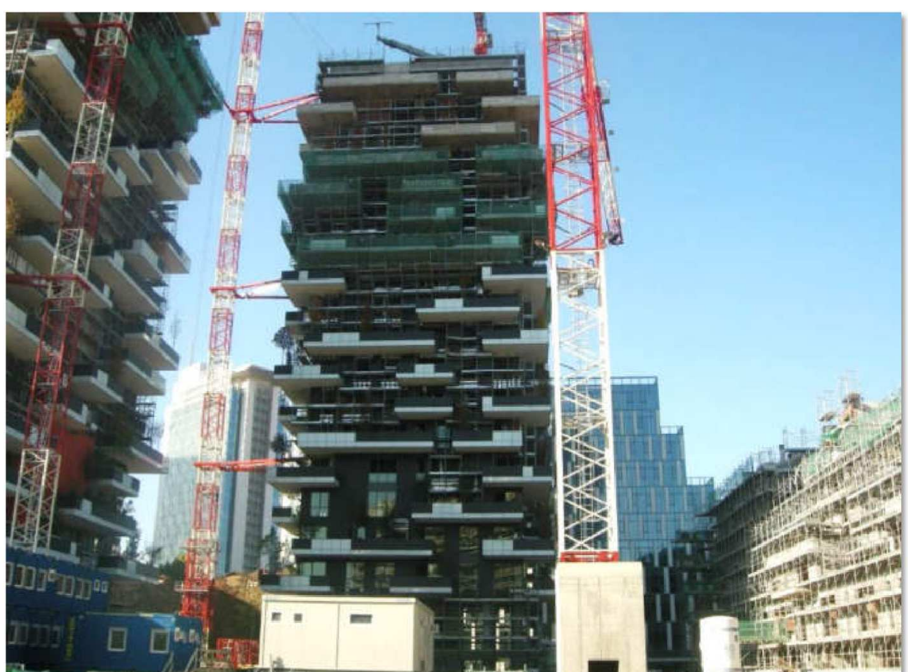
» Tie-Down Anchor Detail






# Bosco Verticale („Vertical Forest“; Milan, Italy)

- » Residential Building
- » Subway and Earthquakes
- » Support Load 250,000 kN
- » Support Frequency 3.1 Hz



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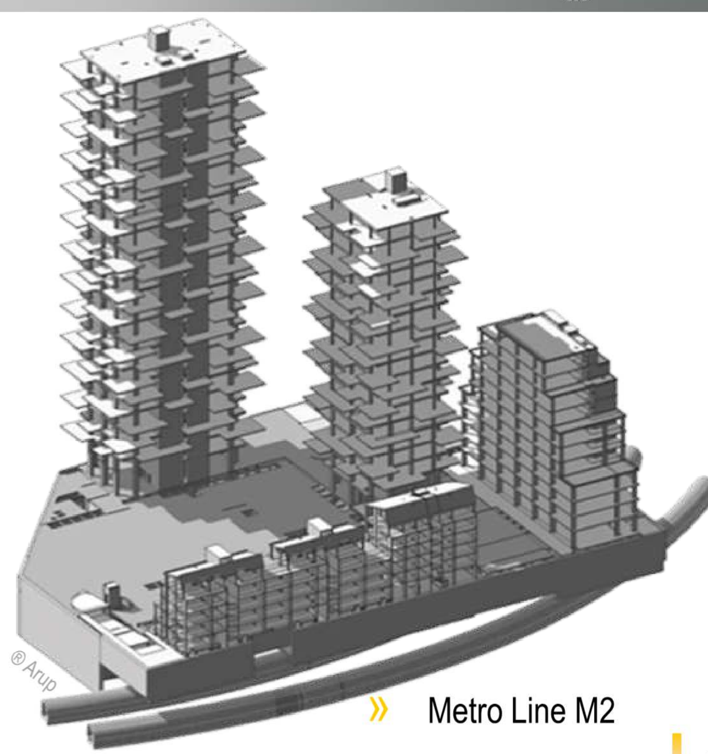
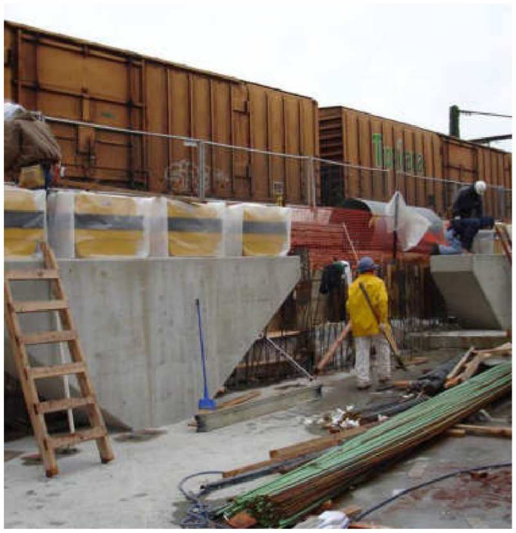


# Bosco Verticale („Vertical Forest“; Milan, Italy)



# 425 3rd Street SW, Washington, D.C.

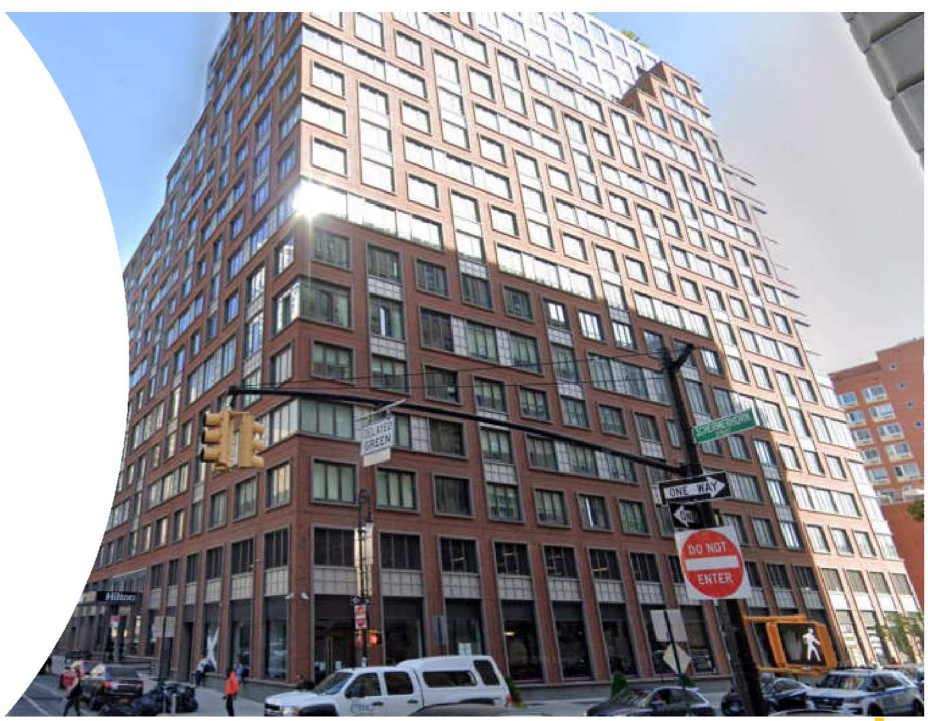
## 425 3rd Street SW, Washington, D.C.



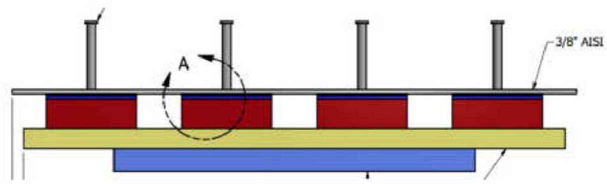


## 71 Smith / Hilton Hotel, Brooklyn, New York

- 19 Story Hotel and Condo above Subway
- Rubber Bearings, 7 Hz Partial Building Isolation



# 71 Smith / Hilton Hotel, Brooklyn, New York






# Retrofit Base Isolation

# St. Remigius Church, Bergheim, Germany

Retrofit Base Support of 13th Century Church



# St. Remigius Church, Bergheim, Germany

» **Bergheim, Germany**

# St. Remigius Church, Bergheim, Germany

» **Bergheim, Germany**



# St. Remigius Church, Bergheim, Germany

» **Bergheim, Germany**

## Folgate Street Hotel, London, UK

» **London, UK**



## Folgate Street Hotel, London, UK

» **London, UK**

# Folgate Street Hotel, London, UK

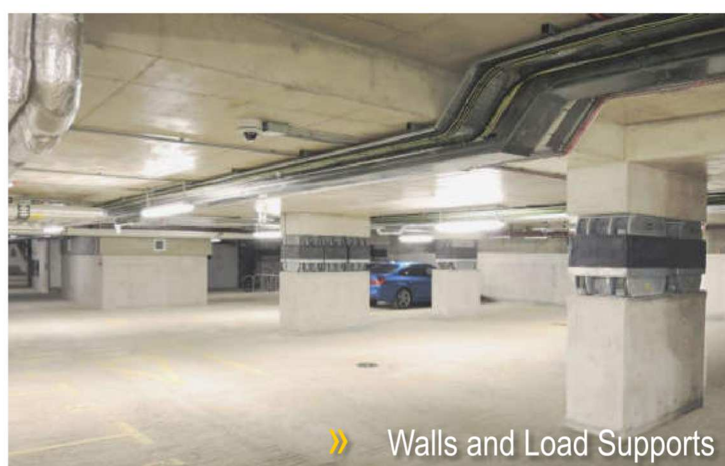
» **London, UK**



# King’s Cross Art House, London, UK

- **King’s Cross Art House, London (2013)**

» Elevator Shaft



» Walls and Load Supports

# Helipad Support Structure

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## Harbor UCLA Hospital, Los Angeles, CA

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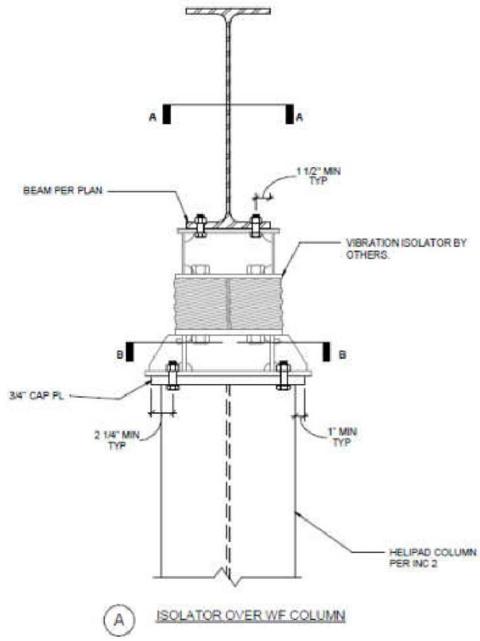
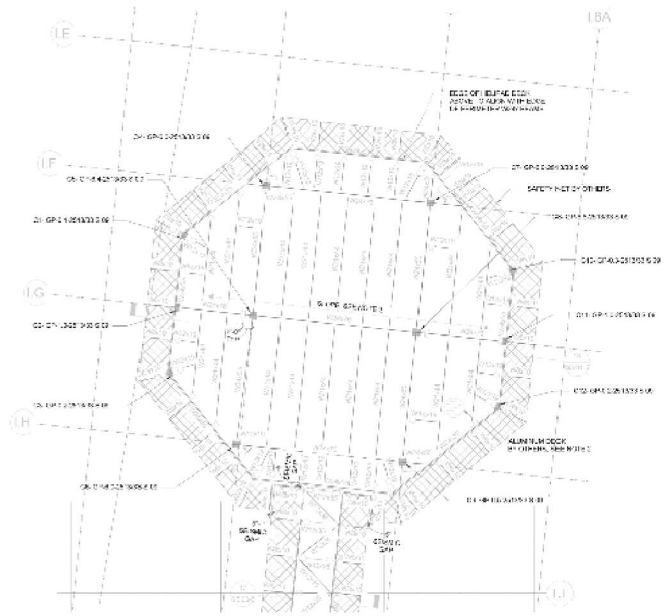
# Harbor UCLA Hospital, Los Angeles, CA





# Harbor UCLA Hospital, Los Angeles, CA



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Thank you for your attention.

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