

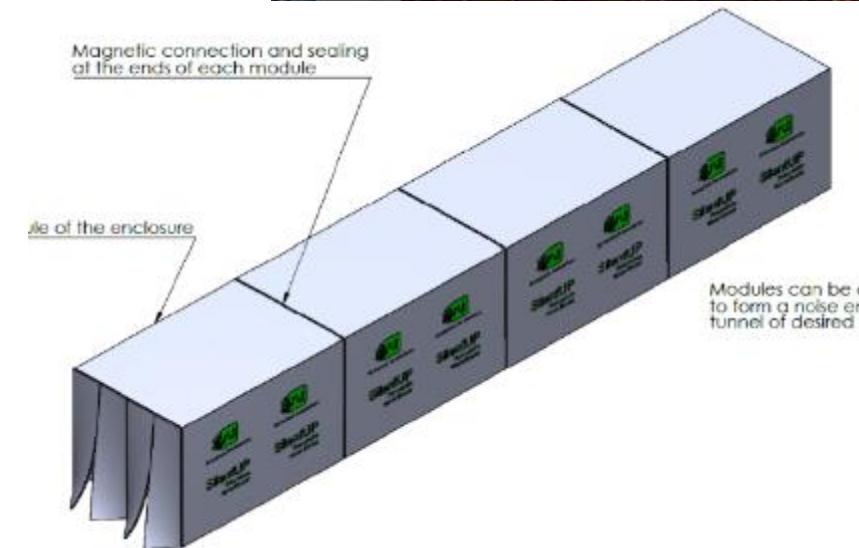
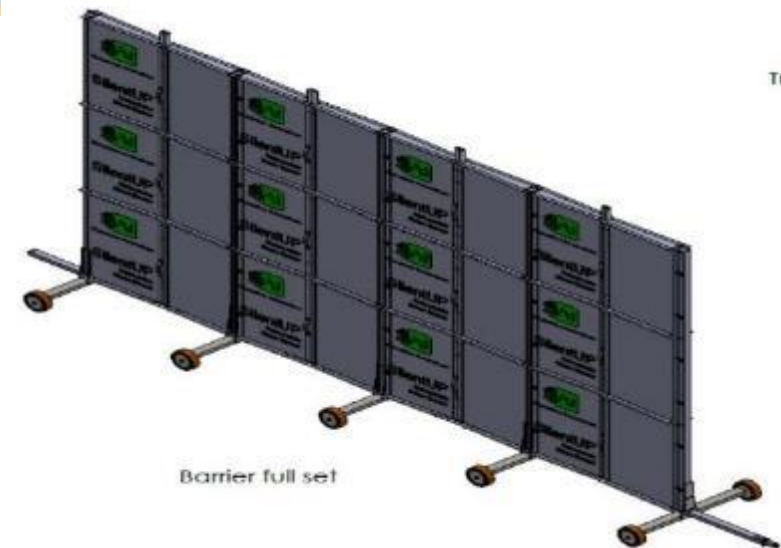
Construction Noise Control Innovative Cases Sharing

Wilson Ho and Dragon Tsui

Wilson Ho and Associates Limited

27 June 2022

Supported by:  香港聲學學會
Hong Kong Institute of Acoustics



Wilson Ho

• Education & Early Career

- MSc S&V Studies, ISVR, 1992-93
- Arup Acoustics HK, 1993 - 2002
- Wilson, Ihrig & Associates HK, 2002 – 05

• Wilson Acoustics since 2005

- Rail vibration & groundborne noise reduction
- Curve track noise & corrugation suppression
- Construction noise control for tunnel projects
- TBM GBN assessment, monitoring and control
- Public Address (PA) acoustic design
(All MTR new stations in the last 15 years)

Patents for Commercial Products:

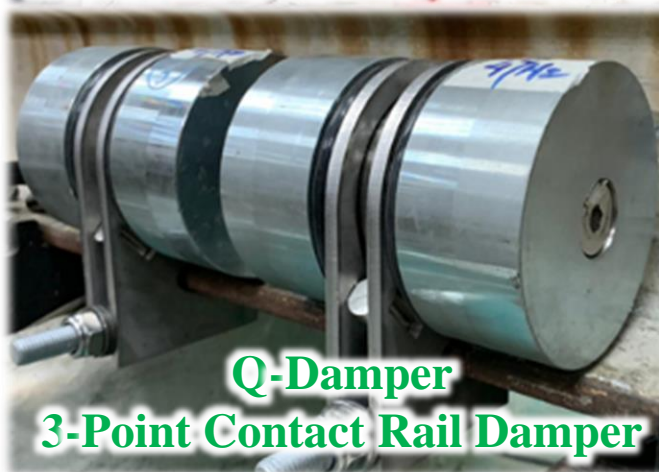
- MDTMD Rail Damper, 2008, 2010
- Retractable Barrier SilentUP® 2014, 2017
- 3-Point Contact Damper (Q-Damper) 2020
- Piling Magnetic Tuned Mass Damper 2021
- Magnetic Diamond Grinder (Q-Grinder) 2022



MDTMD Rail Damper



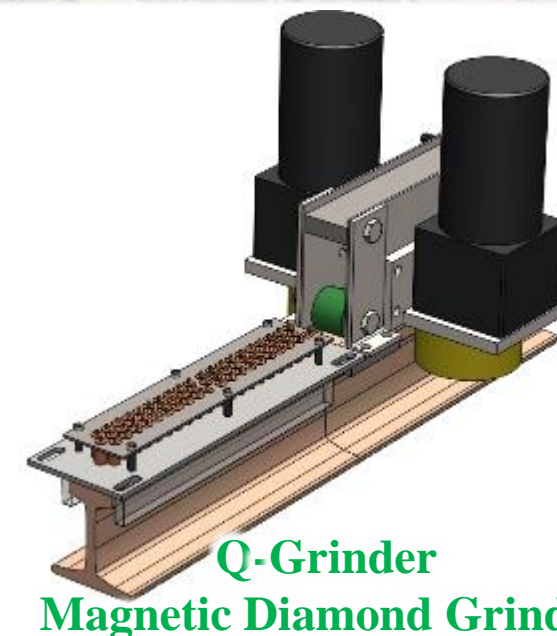
Retractable Barrier SilentUP®



Q-Damper
3-Point Contact Rail Damper



Magnetic Tuned Mass Damper



Q-Grinder
Magnetic Diamond Grinder



Dragon Tsui

• Education & Career

- BEng in Mechanical Engineering , The University of Hong Kong, 2010
- Wilson Acoustics Limited, 2010 - 2020
- Wilson Ho and Associates Limited, 2020 – Present

• Professional Area

- Drill & Break/Blast, and TBM Airborne & Groundborne Noise Consultancy
- Construction Noise Mitigation Design
- Noise Measurements; Noise and Vibration Monitoring
- Construction Noise Permit (CNP) Application

• Major Project Experiences

- Central Kowloon Route (CT, YMTE, HMT)
- ED/2018/04 Trunk Road T2
- NE/2015/01 Tseung Kwan O Lam Tin Tunnel – Main Tunnel and Associated Works
- CE 17/2016 (EP) A Study on Construction Noise Control in Hong Kong – Feasibility Study
- CV/2012/08 Liantang / Heung Yuen Wai Boundary Control Point North Portal Formation and Infrastructure Work
- MTR SIL(E)-904 Lei Tung Station, South Horizons Station and Tunnels



Construction Noise Control Innovative Cases Sharing

A. Tunnel Projects (Dragon Tsui)

1. Central Kowloon Route (CKR)
2. Trunk Road T2
3. Shatin Sewage Treatment Works to Caverns (STSTWC)
4. Inter-reservoirs Transfer Scheme (IRTS)
5. Liantang / Heung Yuen Wai Boundary Control Point (LTH BCP)

B. Innovative Products (Wilson Ho)

1. Retractable Noise Barrier SilentUP[®]
 - Vertical, Cantilever trial,
 - Movable by trolley
 - Horizontal Opening Cover
2. Lightweight Noise Enclosures
 - Wheeled Enclosure
 - Long Enclosure by Modular Connections
3. Magnetic Tuned Mass Damper
 - Hydraulic Breaker,
 - Sheet Piling
 - H-Piling



Construction Noise Control Innovative Cases Sharing - Preview

A: Tunnel Projects



A: Tunnel Projects

Noise Enclosure with Solid Panels

Insertion Loss : 21 to 51dB(A) (Accepted by Authority)

- Panel STC 35 to 60
- Door gaps sealing
- Huge Silencers
- Ventilation Fans Enclosures
- On-site Performance tests (>10dB(A))



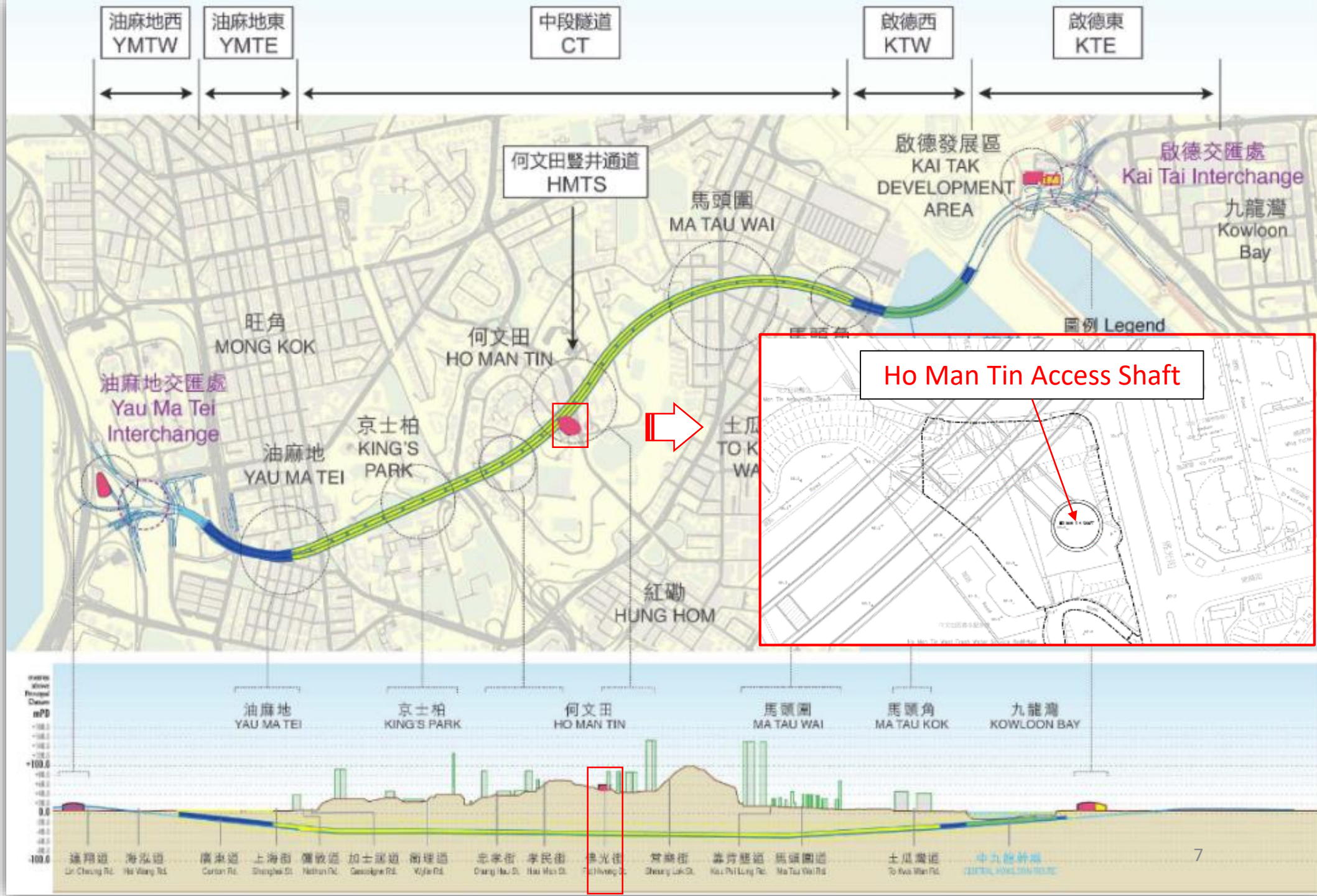
CKR



T2



Central Kowloon Route (CKR)



Construction Noise Permit (CNP) Assessment in Hong Kong

PME	SWL, dB(A)	Qty	Distance, m	Dist. Attn., dB(A)	Barrier Effect, dB(A)	Façade corr., dB(A)	Multiple site corr., dB(A)	Noise Level, dB(A)
Hydraulic Breaker	122	2	35	-39	0	3	7	96
Loader	112	1	35	-39	0	3	7	83
Jumbo Drill	123	3	35	-39	0	3	7	99
Ventilation Fan	108	4	35	-39	0	3	7	85
Combined noise level at NSR								101 dB(A)
Criteria (ASR=B @ 2300-0700)								50 dB(A)
Noise Exceedance								51dB(A)



Table 1 — Area Sensitivity Ratings (ASRs)

Type of Area Containing NSR \ Degree to which NSR is affected by IF	Not Affected	Indirectly Affected	Directly Affected
(i) Rural area, including country parks or village type developments	A	B	B
(ii) Low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
(iii) Urban area	B	C	C
(iv) Area other than those above	B	B	C

Time Period \ ASR	A	B	C
All days during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the day-time and evening (0700 to 2300 hours)	60	65	70
All days during the night-time (2300 to 0700 hours)	45	50	55

IF = influence factor, e.g., major roads with annual average daily traffic >30,000

Construction Noise Permit (CNP) Assessment in Hong Kong

PME	SWL, dB(A)	Qty	Distance, m	Dist. Attn., dB(A)	Barrier Effect, dB(A)	Façade corr., dB(A)	Multiple site corr., dB(A)	Noise Level, dB(A)
Hydraulic Breaker	122	2	35	-39	-51	3	7	45
Loader	112	1	35	-39	-51	3	7	32
Jumbo Drill	123	3	35	-39	-51	3	7	48
Ventilation Fan	108	4	35	-39	-51	3	7	34
Combined noise level at NSR								50 dB(A)
Criteria (ASR=B @ 2300-0700)								50 dB(A)
Compliance								



Table 1 — Area Sensitivity Ratings (ASRs)

Type of Area Containing NSR \ Degree to which NSR is affected by IF	Not Affected	Indirectly Affected	Directly Affected
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Construction Noise Permit (CNP) Assessment in Hong Kong

- Assessment based permit system, granted ONLY when receiver noise level \leq criteria
 - Even the noise is inaudible in real situation (e.g. SPME)

$$\text{Receiver noise level} = \text{SWL of PMEs} - \text{distance attenuation} - \text{barrier effect} + \text{3dB façade correction} + \text{multiple site correction}$$

Standard
Fixed

SWL values according to TM / QPME / ISO measurement for individual machine
For >10dB barrier effect, on-site verification is required
Up to +7dB(A) subject to concurrent sites nearby

Table 1 — Area Sensitivity Ratings (ASRs)

Type of Area Containing NSR \ Degree to which NSR is affected by IF	Not Affected	Indirectly Affected	Directly Affected
(i) Rural area, including country parks or village type developments	A	B	B
(ii) Low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
(iii) Urban area	B	C	C
(iv) Area other than those above	B	B	C

Noise Criteria

Table 2 — Basic Noise Levels (BNLs)

Time Period \ ASR	A	B	C
All days during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the day-time and evening (0700 to 2300 hours)	60	65	70
All days during the night-time (2300 to 0700 hours)	45	50	55

Remark: Other corrections may be applied subject to site conditions



27m x 27m Shaft Enclosure (51dB(A) noise reduction)

STC55 proprietary panel (102mm)
24mm Gypsum board and infill
(2 layers of 12mm)

+5mm thick steel plate underneath
(fulfil CEDD Mines Division
requirement for blasting)

125mm thick airgap

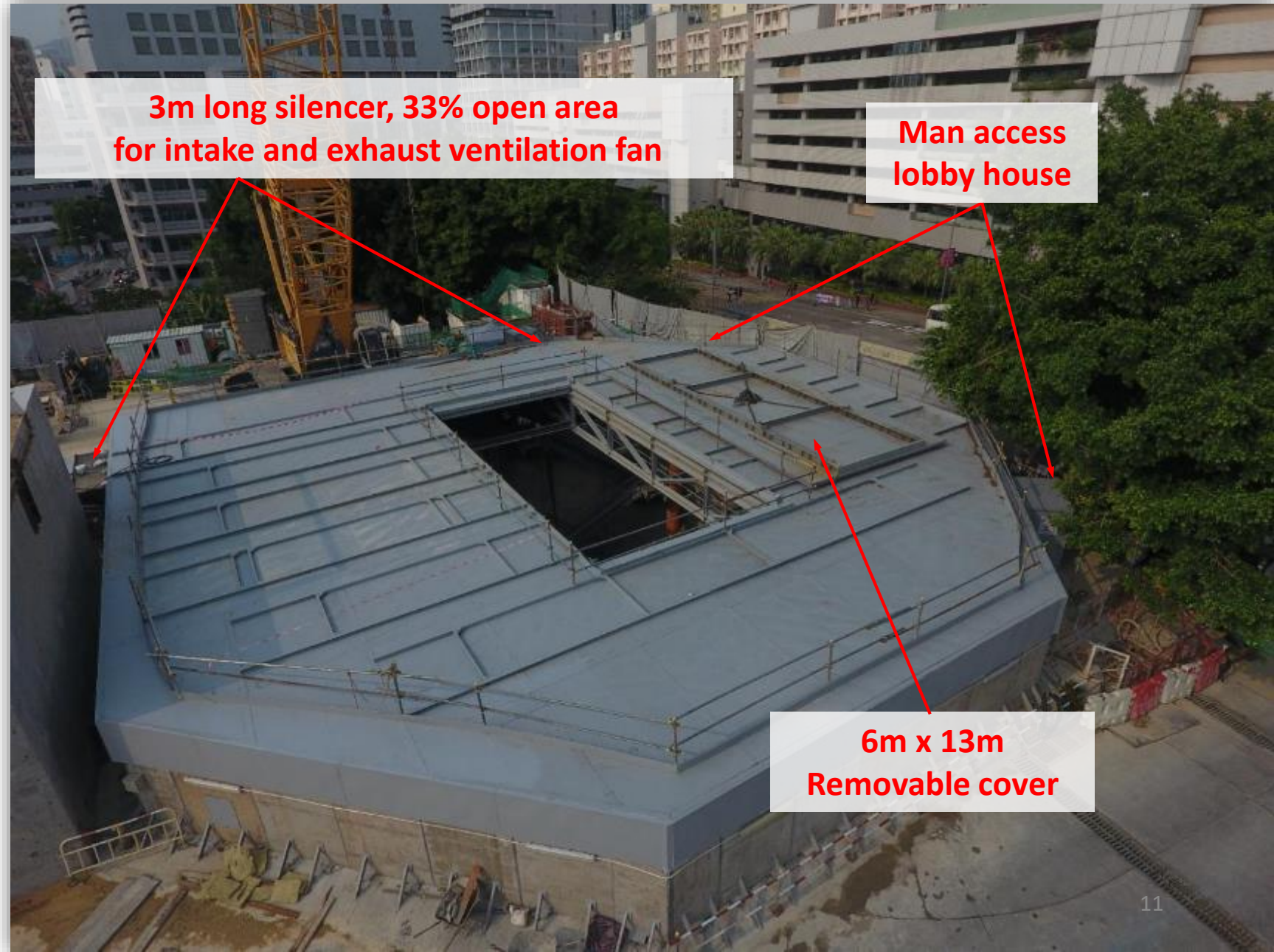
+ 100mm Absorptive lining
underneath

Overall thickness: 332mm

3m long silencer, 33% open area
for intake and exhaust ventilation fan

Man access
lobby house

6m x 13m
Removable cover



Essential Items for Noise Enclosure

Lobby door for people access



Silencer for ventilation

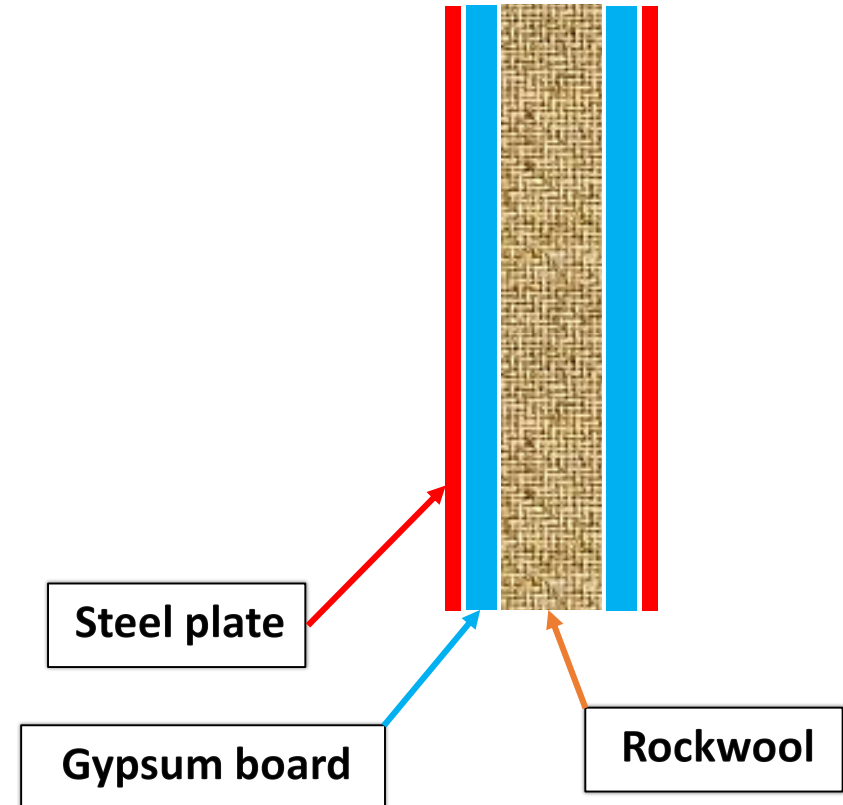


Essential Items for Noise Enclosure

Absorptive lining



Damping of steel panel



Panel Gap Sealing by Step Joint Gasket & Double Gasket



Performance Test Site Arrangement (SilentUP® to Reduce B/G Noise)



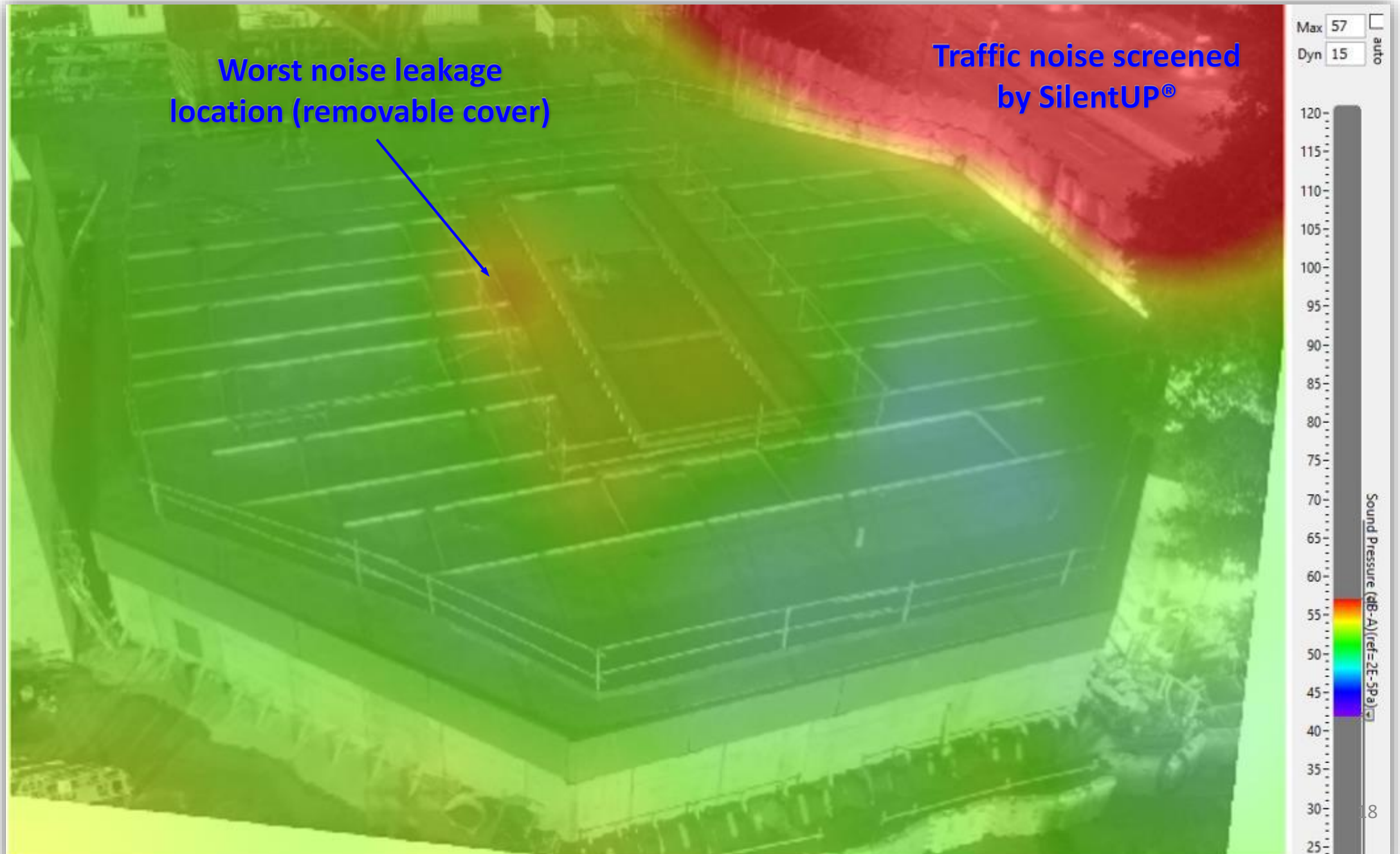
Receiver mic. R2 (cover opened)

Loudspeakers
(cover opened)

Acoustic Camera to identify if any noise leakage other than removable cover

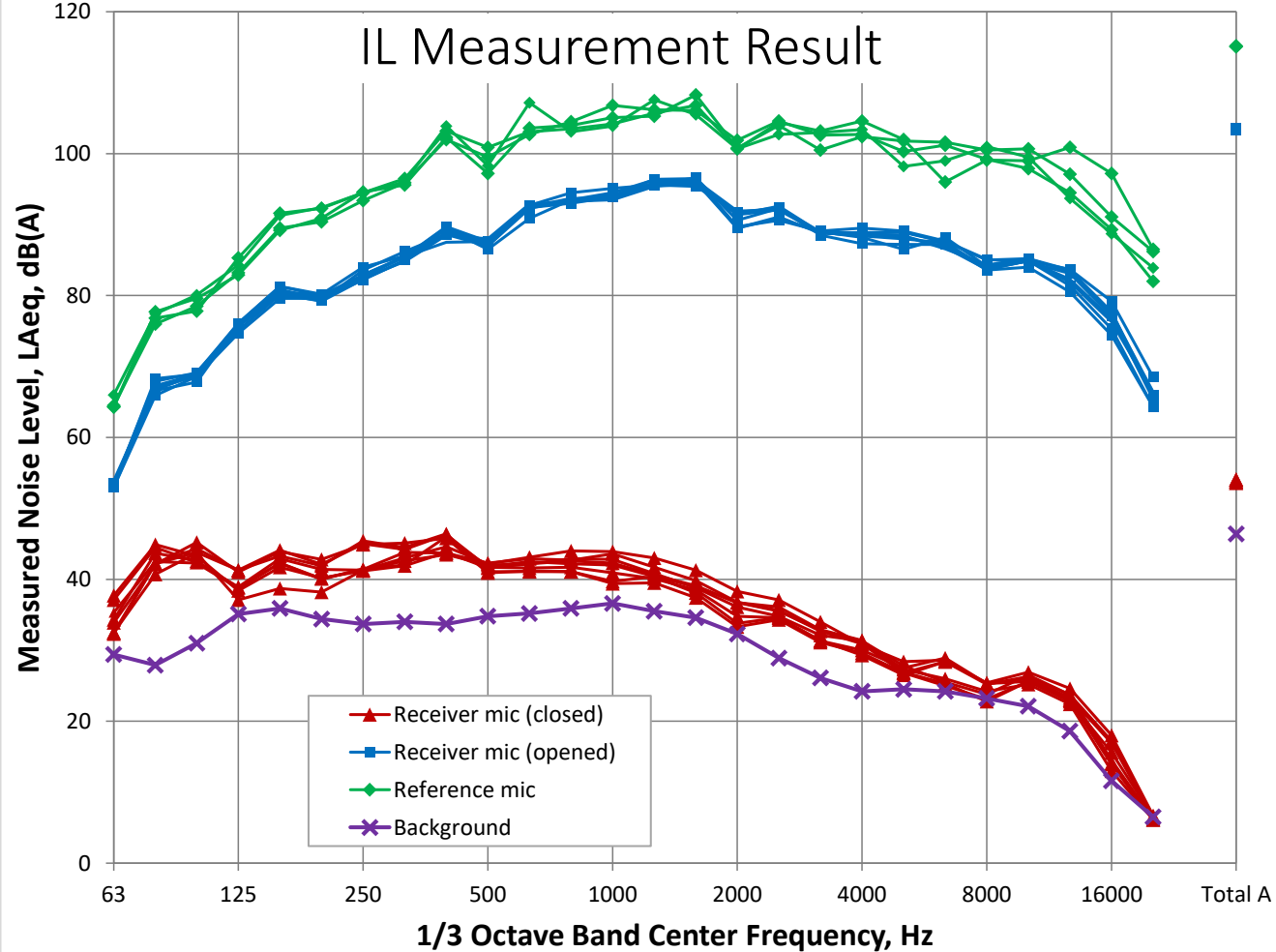


Insignificant Noise Leakage Verified by Acoustic Camera



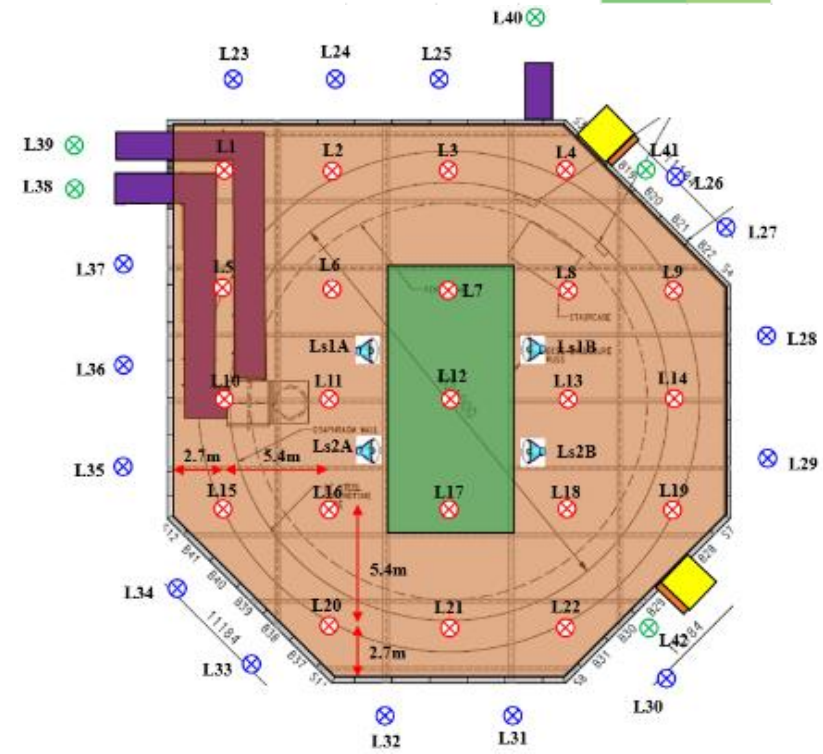
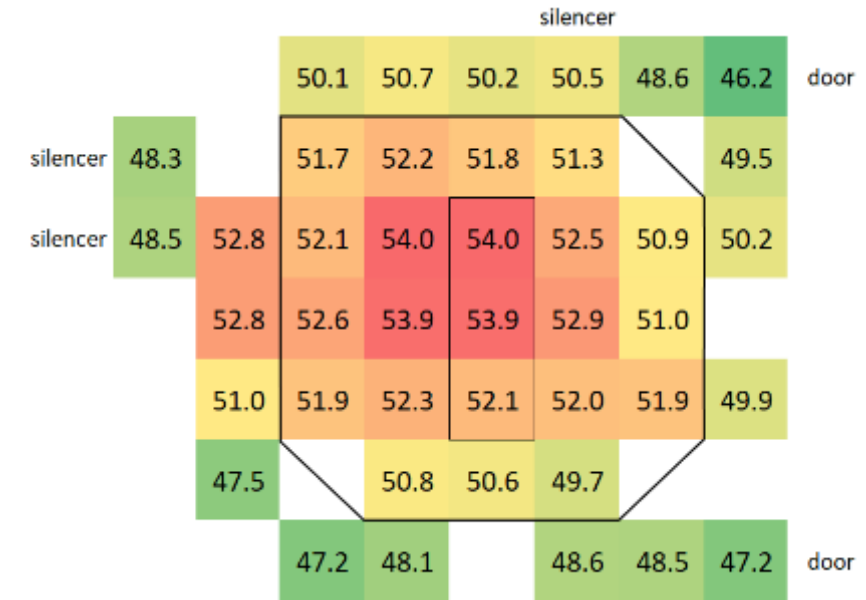


Receiver mic. R2 (cover closed)



Receiver Mic. Location	Removable Cover Opened				Removable Cover Closed				IL, dB(A)
	Avg. Ref. Mic. Noise Level	Receiver Mic. Noise Level			Avg. Ref. Mic. Noise Level	Receiver Mic. Noise Level			
		L _{eq,15s}	B/G	B/G Corrected		L _{eq,15s}	B/G	B/G Corrected	
R1	114.6	103.5	56.2	103.5	115.1	54.1	46.4	53.3	
	114.6	103.5	56.2	103.5	115.1	53.8	46.4	52.9	
	114.6	103.3	56.2	103.3	115.1	54.1	46.4	53.3	
	114.6	103.4	56.2	103.4	115.1	54.0	46.4	53.2	
R2	114.6	103.5	56.2	103.5	115.1	53.5	46.4	52.6	
	114.6	103.3	56.2	103.3	115.1	53.8	46.4	52.9	
	114.6	103.4	56.2	103.4	115.1	53.6	46.4	52.7	
	114.6	103.6	56.2	103.6	115.1	53.6	46.4	52.7	
Average	114.6			103.4	115.1			52.9	51.0

Noise Leakage Measurement Result



Liantang/Heung Yuen Wai BCP **(10 Tunnel Portal Acoustic Doors)**



33-35dB(A) IL Acoustic Door

- Acoustic Door of 5mm thick steel plate
- Lined with 100mm thick rockwool
- Double door for man access
- 1 intake silencer
(3.6m (L) x 2.4m x 2.8m)
- 2 exhaust silencers
(3.6m (L) x 1.9m x 1.6m)
- Verification with the authority



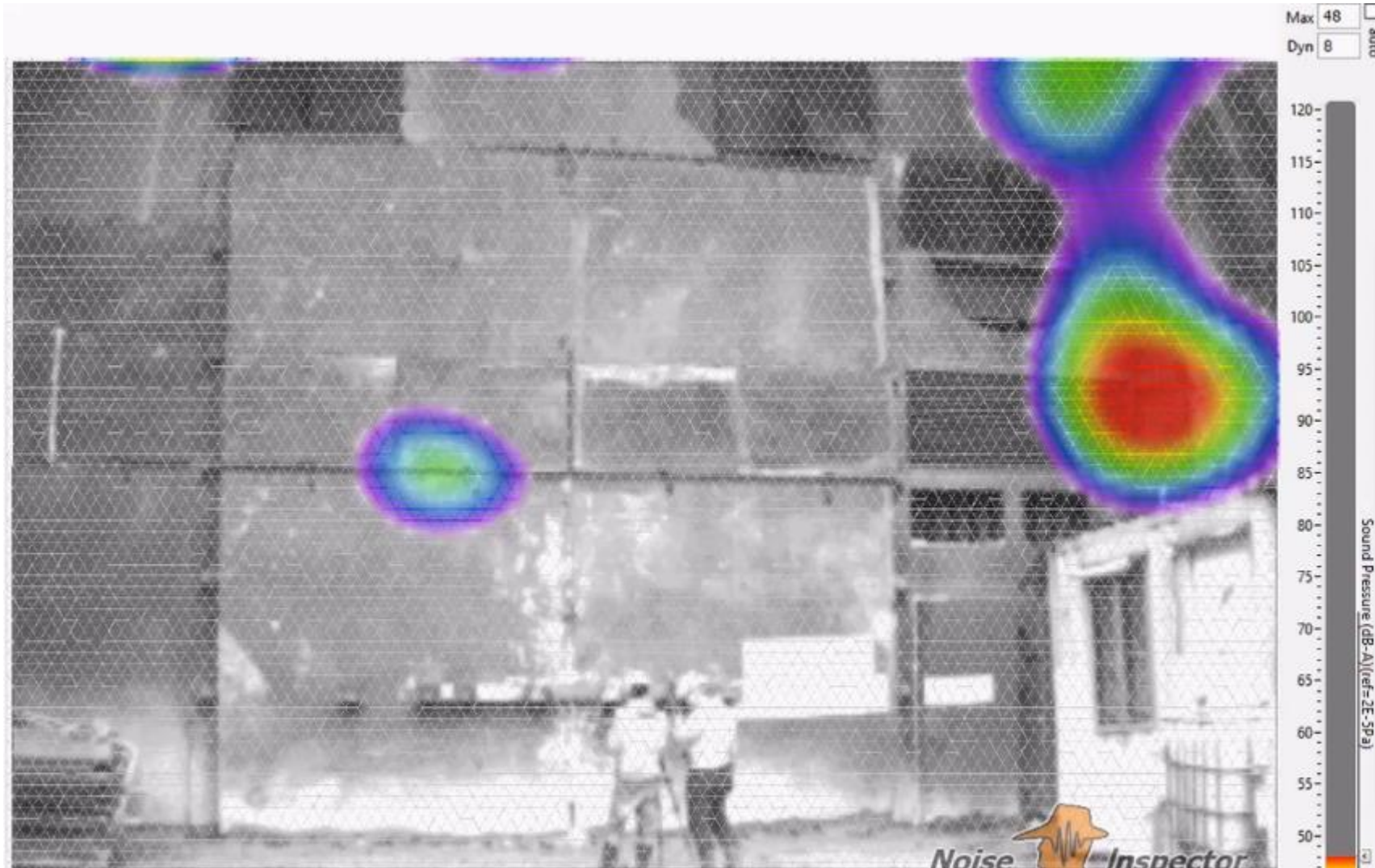
Acoustic Camera

Convenient detection through acoustic camera

1. Detect leakage points
2. Repair and reseal
3. Detect again until target result obtained



Acoustic Camera





LTH BCP North Portal Southbound
Tunnel Door,
1st Stage in 2014, IL=42dB(A)



LTH BCP North Portal Southbound
Tunnel TBM Door,
2nd Stage in 2015, IL=34dB(A)



LTH BCP North Portal Northbound
Tunnel Door,
1st Stage in 2015, IL=37dB(A)



LTH BCP North Portal Northbound
Tunnel Door,
2nd Stage in 2016, IL=37dB(A)



LTH BCP South Portal Southbound
Tunnel Door,
1st stage in 2015, IL=31dB(A)
(internal view)



LTH BCP South Portal Southbound
Tunnel Door,
2nd stage in 2016, IL=34dB(A)
(IL of left door=34dB(A),
IL of right door=37dB(A))



LTH BCP South Portal Northbound
Tunnel Door, 2015, IL=37dB(A)
(External view)



LTH BCP Mid-vent Adit Tunnel
Door, 2015, IL=39dB(A)

Ventilation Fans Noise Mitigations



LTH BCP North Portal Enclosed Mortar Plant,
SWL of Components=78-95dB(A)



LTH BCP Enclosed Vent. Fans at Three Tunnel Portals,
SWL=84-91dB(A) vs. 108dB(A) for standard one

**CKR HMT Shaft Enclosure, 1st Stage in 2019,
IL=51dB(A)**



CKR HMT Shaft Enclosure, 2nd Stage in 2019, IL=51dB(A)
(Shape changed and removable cover enlarged to fit the construction need)

CKR HMT Enclosure, 3rd Stage in 2020, IL=31dB(A)



IRTS TBM Enclosure, 2020, IL=21dB(A)



T2 Trunk Road Tunnel Door, 2020, IL=30dB(A)



**STSTWC Tunnel Enclosure, 2020,
IL=43dB(A)**



CKR MTK Hydraulic Shaft Cover,
1st Stage in 2021, IL=41dB(A)



CKR MTK Enclosure, 2nd Stage in 2021, IL=36dB(A)



Noise enclosure with Flexible Panels

Insertion Loss : 15 to 27dB(A)

- Panel STC 20 to 27
- Quick installation for night works
- On-site performance tests



CKR D-wall Construction Enclosure



D-wall Construction Enclosure , 15x18x7m (H),
2020, IL=21-25dB(A) for white noise

For D-wall construction
Chiseling and grabbing carried out by mobile crane

CKR Enclosure Under Flyover by Retractable Noise Barrier



External
view



Internal view

2021, IL=17-27dB(A) for white noise

For D-wall construction

Chiseling and grabbing carried out by mobile crane

Construction Noise Control Innovative Case Sharing

A. Tunnel Projects (Dragon Tsui)

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2. Trunk Road T2
3. Shatin Sewage Treatment Works to Caverns (STSTWC)
4. Inter-reservoirs Transfer Scheme (IRTS)
5. Liantang / Heung Yuen Wai Boundary Control Point (LTH BCP)

B. Innovative Products (Wilson Ho)

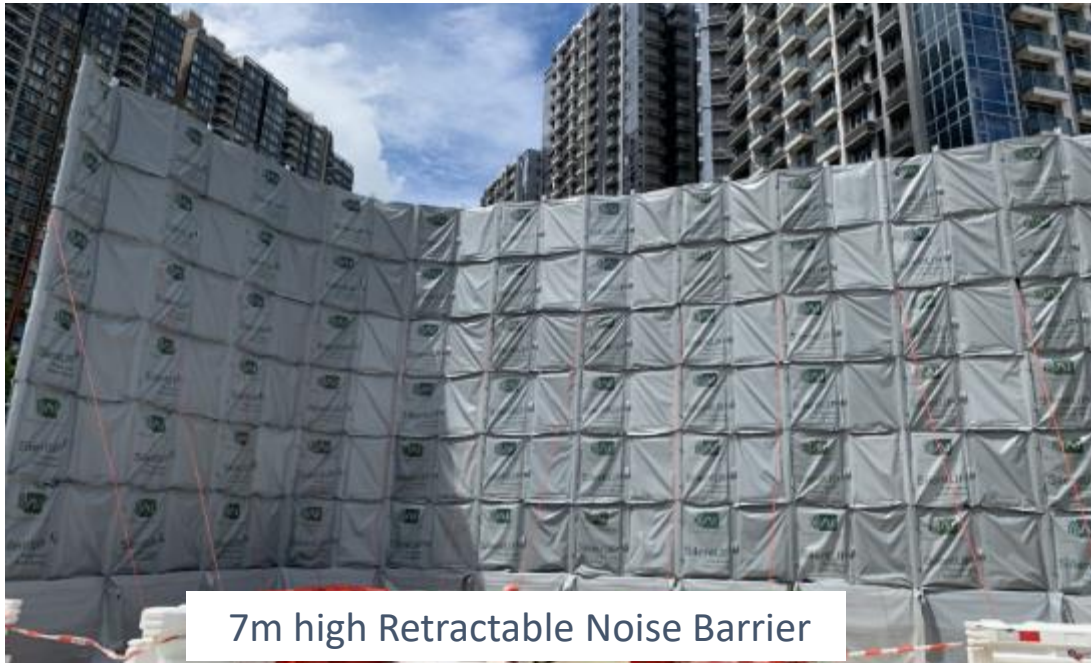
1. Retractable Noise Barrier SilentUP[®]
 - Vertical, Cantilever trial,
 - Movable by trolley
 - Horizontal Opening Cover
2. Lightweight Noise Enclosures
 - Wheeled Enclosure
 - Long Enclosure by Modular Connections
3. Magnetic Tuned Mass Damper
 - Hydraulic Breaker,
 - Sheet Piling
 - H-Piling

End of Part A



B1. Innovative Products

Retractable Noise Barrier



7m high Retractable Noise Barrier



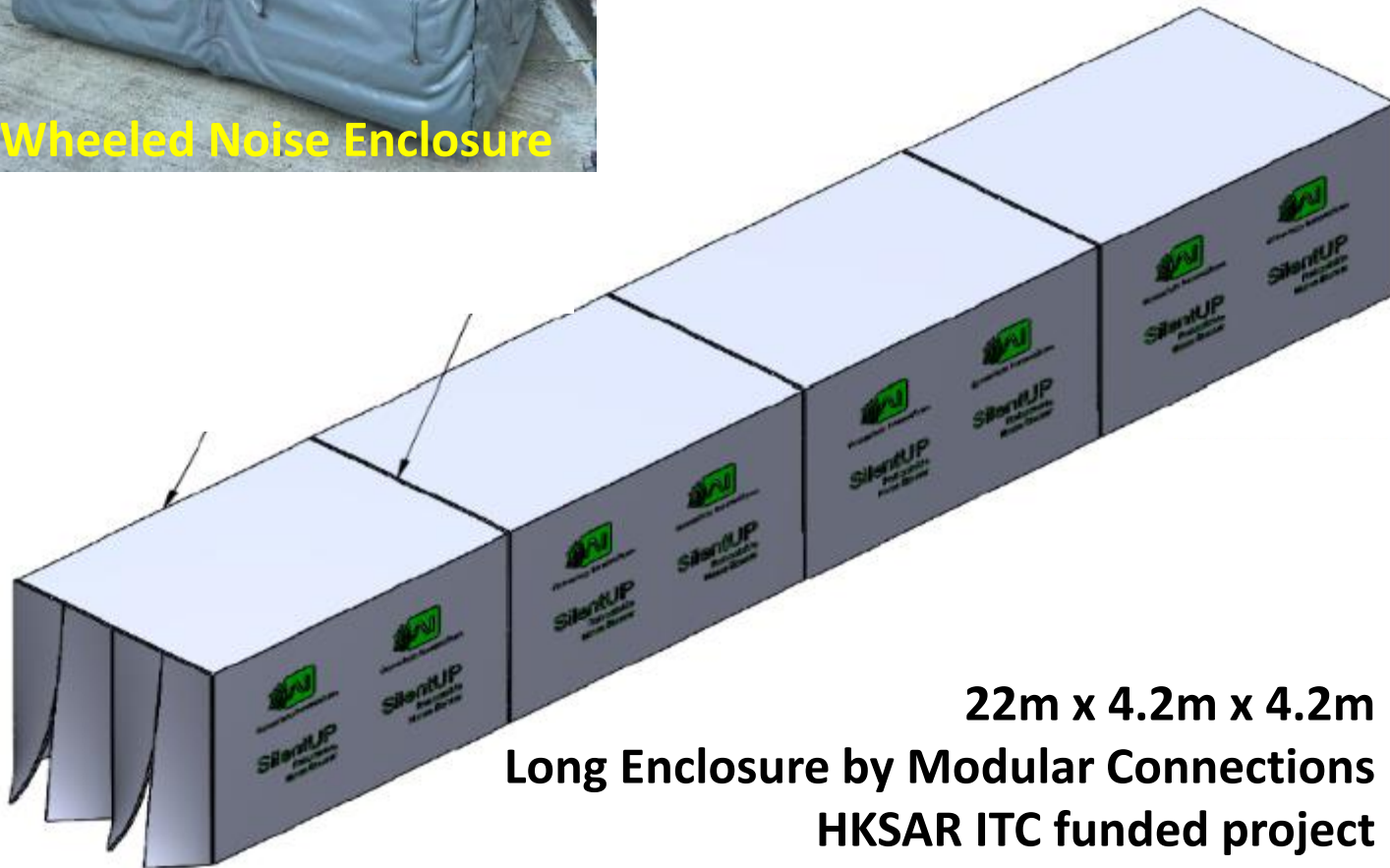
8 x 11m, Installation within 1 hour

B2. Innovative Products

Lightweight Noise Enclosures



Wheeled Noise Enclosure



22m x 4.2m x 4.2m
Long Enclosure by Modular Connections
HKSAR ITC funded project



Modular Size 5.4m x 4.2m x 4.2m



B3. Innovative Products

Magnetic Tuned Mass Damper (MTMD)



B1. Retractable Noise Barrier vs Other Movable Noise Barrier



Retractable Noise Barrier (Erection without machine)
Up to 7m high, on water barrier



Movable Noise Barrier with concrete counterweight
(max. ~3m high , movement by crane)

Quick Erection without machine (Quiet and can be conducted at nighttime)



Acoustics Innovation

SilentUP®

Retractable Noise Barrier

8m(W) X 5.5m(H) Demonstration
Setup in 17mins

<https://www.youtube.com/watch?v=u83nA1emqQ>



SilentUP® Retractable Noise Barriers

- Up to 7m high
- Fast installation without machine
- No concrete foundation
- Quiet installation even at night
- Magnetic sealing
- 15 to 23dB(A) white noise IL
- Patented V-shape wind load relieving mechanism for occasional gust (>25kph) to reduce structure loading requirements



SilentUP® on-site installation:

<https://www.youtube.com/watch?v=u83nA1emqQ>

SilentUP retractable noise barrier is granted as

“Most commonly applied Pre-approved Technologies among SME”

in CITF建築業創科基金 in 2021 as Advanced Technological Solutions.

中小企最常申請的預先批核科技產品 Most commonly applied Pre-approved Technologies

* 預先批核名單編號

產品類型

* Pre-approved List Code

Product Type

Ve

先進科技方案 Advanced Technological Solutions

* PA19-022 | SilentUP 可拆式隔音屏障 Retractable Noise Barrier

隔音屏障 Noise Barrier

這是一款獨立便攜式隔音屏障，有效阻隔建築噪音達7米高。它只需用水馬代替混凝土作地基及人手可安裝整個隔音屏障。此產品採用自動減輕風荷載機制以顯著減低結構負載要求。它可改善生產力及工地安全。由於屏障可循環再用，故可減少浪費。

SilentUP is a standalone retractable noise barrier for construction noise control up to 7m high. It does not require concrete foundation but water barriers only. The entire structure can be installed by labour without machine aid. SilentUP adopts an Automatic Wind Load Relieving Mechanism which reduces the structure loading requirement significantly. It improves the productivity and safety of work. It is reusable and so waste can be reduced.



Demonstration in HK for Singapore Delegates, 2017



SilentUP championing 23rd Annual Safety, Health and Environmental Awards Convention by LTA in Singapore, 2021

69 Organisations Recognised for Workplace Safety, Health and Environmental Excellence

News Releases 09 Nov 2021

Annual Safety Award Convention (ASAC)

Two new award categories this year to recognise environmental sustainability solutions and safety practices in building Active Mobility infrastructure

69 contractors, operators, organisations and individuals have been recognised by the Land Transport Authority (LTA) today for their outstanding workplace safety, health and environment management practices in 2020 at the 23rd Annual Safety, Health and Environmental Award Convention (ASAC). The theme for this year's convention – "Adapting to New Norms and Continual Training for a Safer and More Productive Workforce" – reflects the challenges of navigating COVID-19 challenges in the past year. It acknowledges the efforts and achievements of companies in adapting and ensuring business continuity during the pandemic in a safe and environmentally-conscious manner.

Championing innovative solutions to promote environmental sustainability

2. In addition to building a safe and healthy workplace, ensuring environment sustainability has become increasingly important. A new award category – Environmental Sustainability Innovation Award – was introduced this year to recognise contractors for their innovative practices at worksites to improve environmental protection and sustainability, as well as to enhance the living environment of our stakeholders near LTA construction sites.

3. Shincon Industrial Pte Ltd and Penta Ocean Construction Co Ltd – Bachy Soletanche Singapore Pte Ltd Joint Venture won the inaugural award for adopting innovative and environmentally-sustainable solutions for their projects. For example, Shincon Industrial Pte Ltd used portable protective flooring to build a temporary footpath when contracted by LTA to carry out infrastructure enhancements under the Seletar flyover. This solution is lighter compared to a conventional concrete footpath and can be reused at other construction sites. The material used also minimises damage to the turf as it is designed with airholes to allow ventilation and sunlight to pass through for grass beneath to grow. Please refer to [ANNEX A](#) for a photo of the portable protective flooring.

4. Penta Ocean Construction Co Ltd – Bachy Soletanche Singapore Pte Ltd Joint Venture was recognised for implementing a new type of retractable noise barrier (Silent Up) for the construction of the North-South Corridor between Suffolk Walk and Novena Drive. Made of a lightweight plastic material, this noise barrier can be easily deployed at locations with space constraints without the use of machinery. It is an efficient solution that helps to address the perennial challenge of construction in dense and built-up environments. Please refer to [ANNEX A](#) for a photo of the silent up noise barrier.

Used by Penta Ocean Construction Co Ltd – Bachy Soletanche Singapore Pte Ltd Joint Venture

Chu Hai Colleague – Works for utilities under road surfaces

Major noise sources:

Nearest NSR
at 148m



For noise concern, 5m high barrier was required
for construction works from **7pm to 11pm**.

For traffic concern, round-about operation until **9pm**

Finally, **only 2 hours work window** was allowed including
erection of noise barrier.

5m high Noise Barrier

SilentUP Noise Barrier for CNP application (setup in 15mins)

5m(H) x 10.8m(L)



Liantang/Heung Yuen Wai BCP (5 x 18m SilentUP® Retractable Noise Barriers)



https://www.youtube.com/watch?v=7lviDT_gzU

5m high noise barrier installation time ~15 minutes

Liantang/Heung Yuen Wai BCP (5 x 18m SilentUP® Retractable Noise Barriers)



Mai Po Nature Reserve Infrastructure Upgrade Project, SilentUP® Noise Barriers



4m (H) & 6m(H) x 45m(W)



5m(H) x 105.3m(W) for 3 sides of the site boundary
4m (H) & 6m(H) x 45m(W) along 1 side



Widening of Castle Peak Road, SilentUP® Retractable Noise Barriers



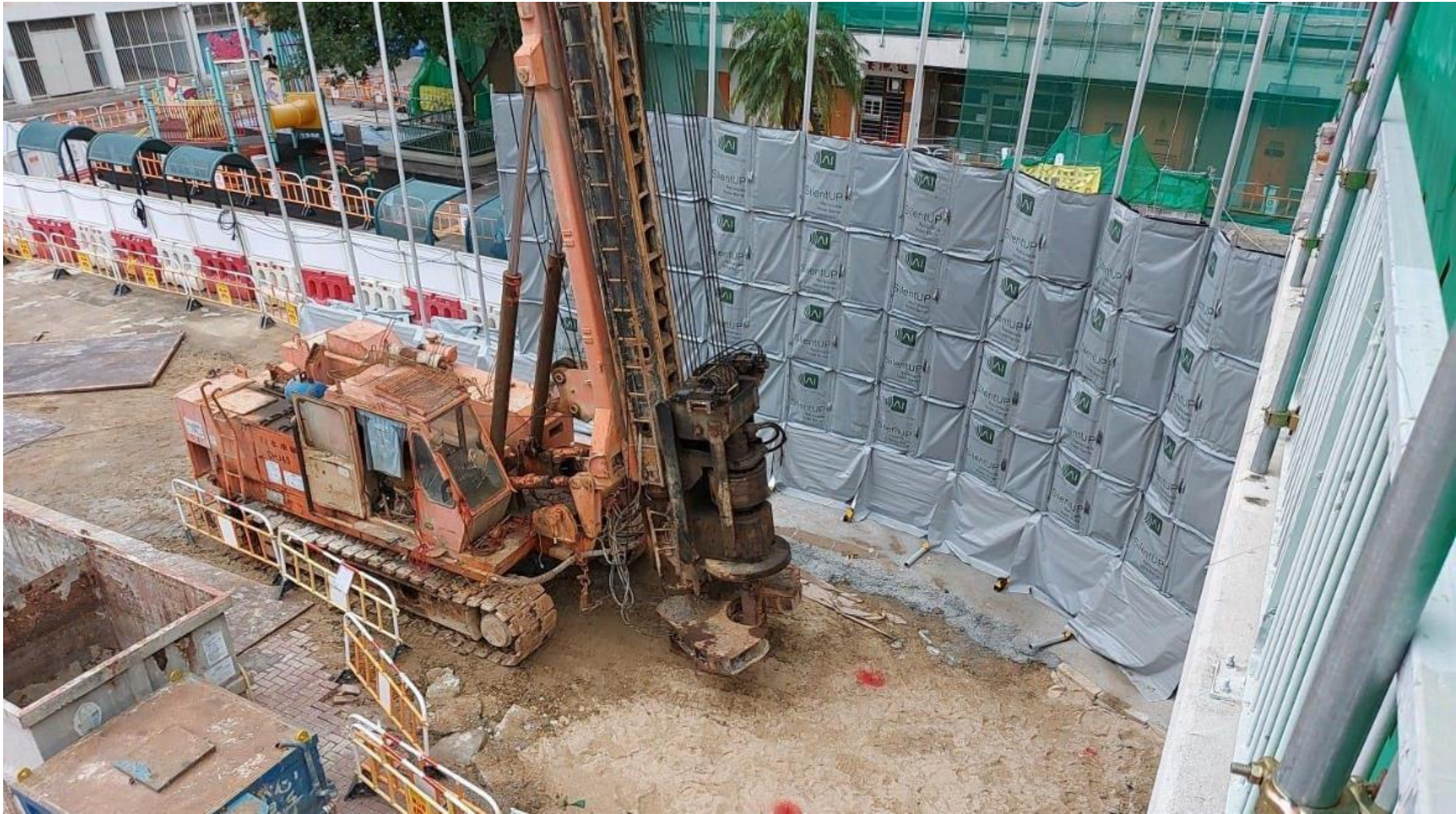
5m(H) x 16m (W)



5m(H) x 50m (W)

Widening of Castle Peak Road

5m(H) x 16m (W) **SilentUP®** Noise Barriers



Taikoo Place redevelopment



5.5m(H) x 8.1m(L)
SilentUP® Noise Barriers

Happy valley underground stormwater storage scheme (6.5m high noise barrier, tear down twice a week for horse racing)



Concrete Pump and
Concrete Lorry Mixer
(SPME)

Match Viewing Area

Difficulties

- 1) Each sector concreting work must be completed in one go due to the structural issue
- 2) Sometime continuous concreting for 10 to 16 hours
- 3) NSRs within ~150 to 250m to 3 sides
- 4) Race horsing 1-2 times a week
- 5) Noise barrier must be removed on horse racing

- 5m(H) x 15m(L)
 - 3m(H) x 19m(L)
 - 6.5m(H) x 5.4m(L)
- SilentUP® Noise Barriers**



Installation less than 3 hours



7m high **SilentUP®** Noise Barriers at Tung Chung New Town Extension



7m high **SilentUP®**
Noise Barriers
for Sheet Piling at
Tung Chung New
Town Extension



B1. Retractable cantilever noise barrier (Trial not yet used)

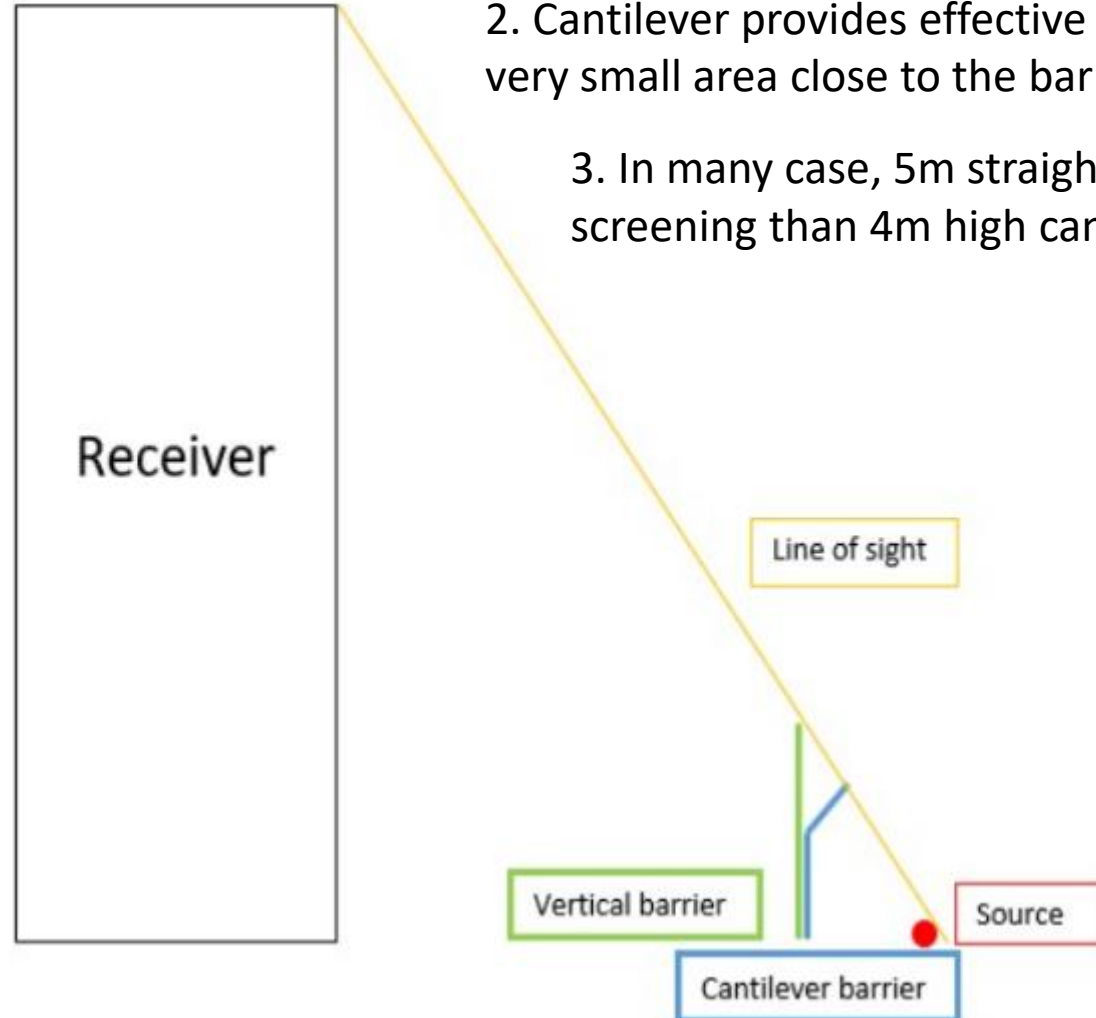
4m high barrier (1m cantilever)



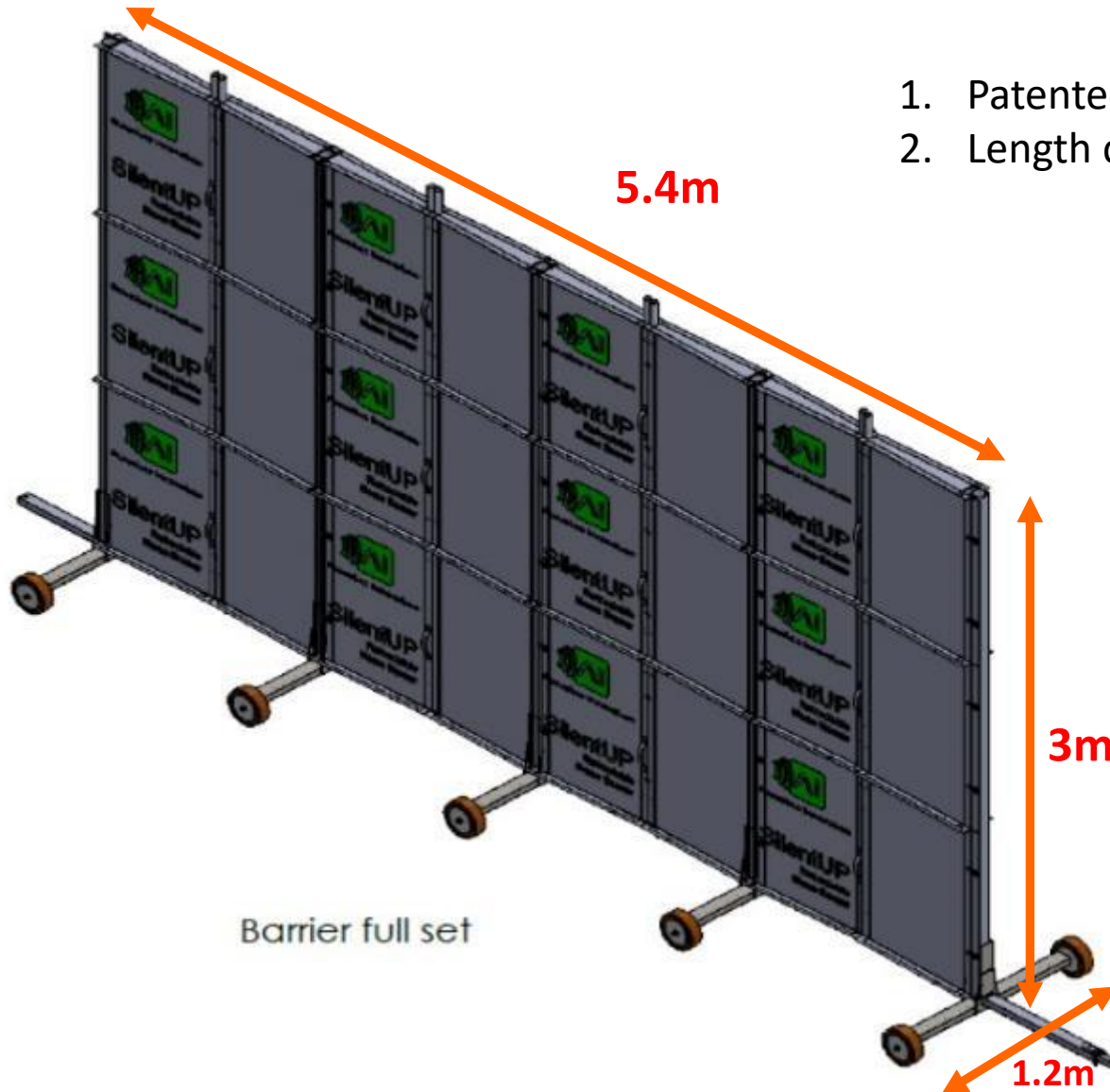
1. Erection of 4m high cantilever barrier is more difficult than 5m straight barrier.

2. Cantilever provides effective screening only for very small area close to the barrier

3. In many case, 5m straight barrier is better screening than 4m high cantilever barrier.

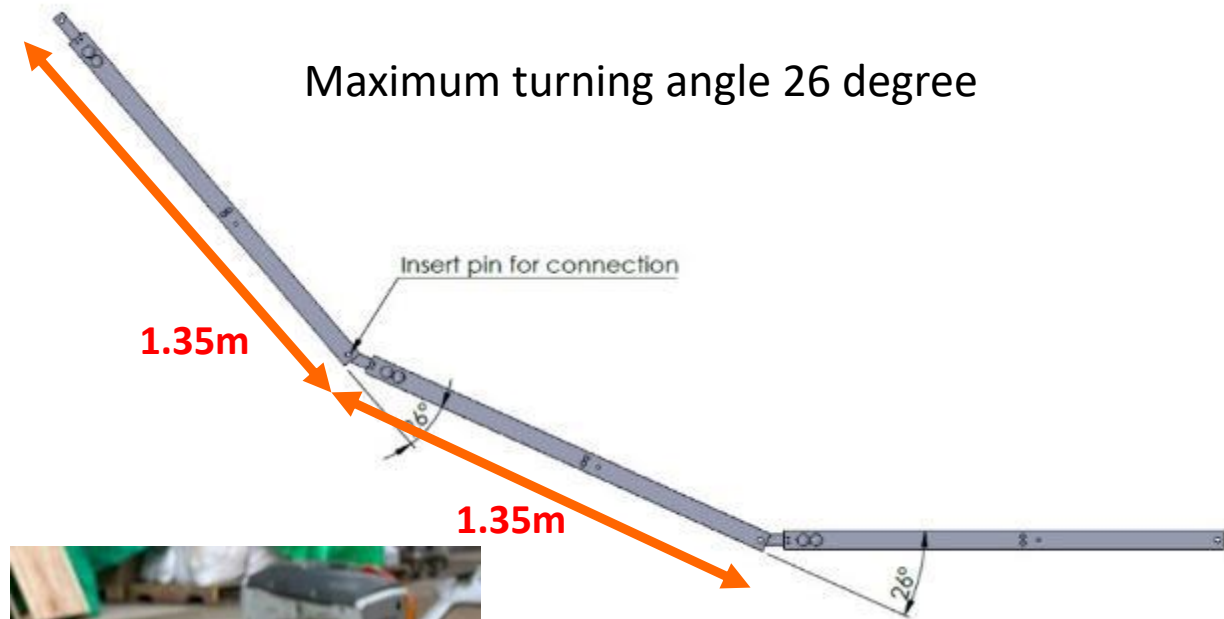


B1. Movable noise barrier trolley (Designed not yet used)



To be pulled by powered trolley

1. Patented wind load relieving mechanism for occasional gust (>25kph)
2. Length can be extended up to 15m



Express Rail Link West Kowloon Station

B1. Retractable Horizontal Cover

- Many openings on the deck to allows material transportation during daytime
- However, under deck construction works needs to be covered during nighttime



PCW to be conducted in Basement



B1. Retractable Horizontal Cover

Express Rail Link West Kowloon Station



~ 8m x 11m



~ 7m x 10m

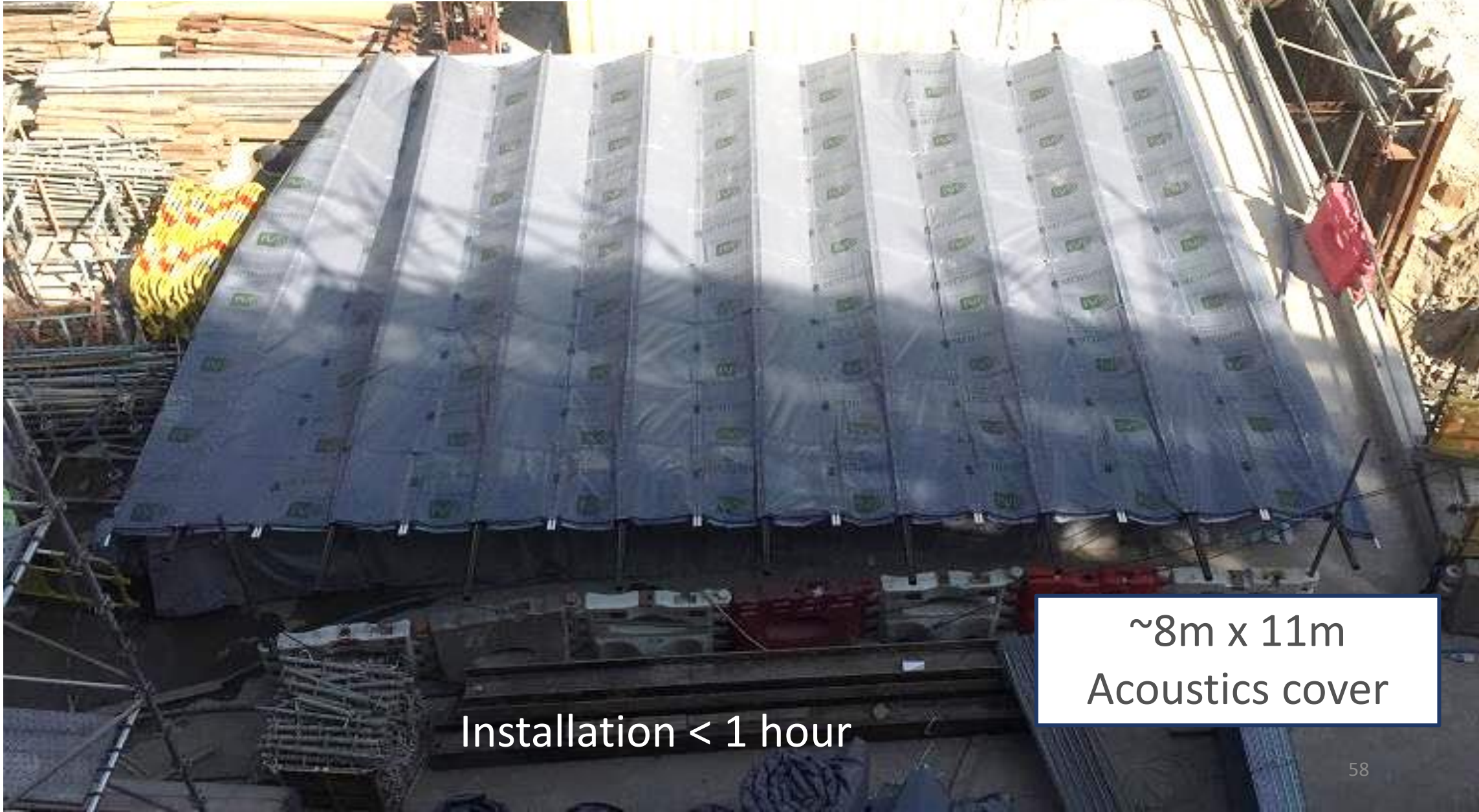
Horizontal opening for material transportation during daytime

Difficulties

- 1) 15dB(A) noise covers are required for PCW at B1 level
- 2) Noise covers are required to remove at day time for material transportation and vehicle access

B1. Retractable Horizontal Cover

Express Rail Link West Kowloon Station



~8m x 11m
Acoustics cover

Installation < 1 hour



B1. Retractable Horizontal Cover

~7m x 10m
Acoustics cover

Installation
around half hour



B2. Wheeled Noise Enclosure (lightweight)



SilentCUBE[®] noise enclosure



B2. Movable Noise Enclosure (lightweight)



Installation of SilentCUBE in 5 mins

<https://www.youtube.com/watch?v=5mQ-0CrG8vo>



B2. Movable Noise Enclosure (lightweight)

M+ Museum (wooden board cutting & steel bar bending)



Difficulties

- 1) Location of wooden board cutting change day by day
- 2) Required 15dB(A) insertion loss for PCW

B2. Movable Noise Enclosure (lightweight)

M+ Museum



2.5mX2.5mX2.2m(H)
SilentCUBE enclosure
- 20dB(A) IL for CNP
application



B2. Movable Noise Enclosure (lightweight)

WSD New Territories West Regional Office (Concreting operation)

Strategy

- Mitigate the noise from vibratory poker



B2. Movable Noise Enclosure (lightweight)

Floor marble tiles
breaking at K11



B2. Movable Noise Enclosure (lightweight)

Floor marble tiles
breaking at Tung Chung
Citygate Outlets



B2. Movable Noise Enclosure

Tung Chung New Town Extension (Generator)



B2. Movable Noise Enclosure – HK Tramway

The electric hand-held grinder (CNP 065), magnetic core drilling machine, grinding part of rail corrugation grinding machine and rail profile grinding machine shall only be operated inside an acoustic enclosure comprised of minimum 50mm thick sound absorbing lining and 10mm thick plywood (or 1mm thick steel) housing, or of acoustic panels with insertion loss of not less than 18 dB(A), so that such equipment is not visible from any nearby noise sensitive receiver.



Solid Enclosure,
movement by lorry crane



Electric grinder for night-time
maintenance work in HK Tramway



SilentCUBE, quiet installation
without using machine and crane.
CNP granted for replacement of
solid enclosure .

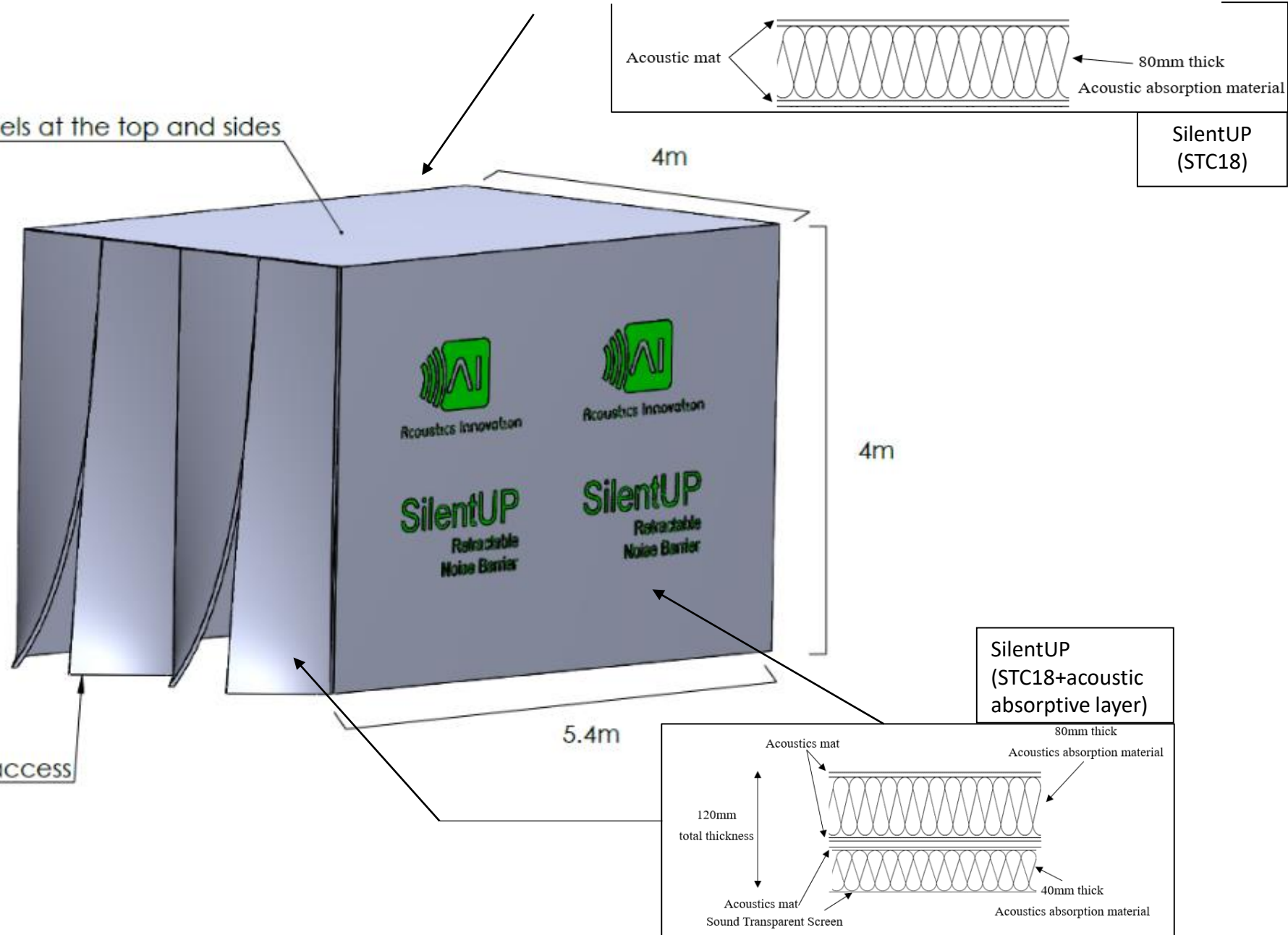
B2. Lightweight Long Enclosure (Prototype not yet used)

Design target :

1. Quiet installation without using crane or other PMEs.
2. Noise reduction >15dB(A)
3. Modular design with each unit weight <300kg
4. Easy connection of multiple units to form long enclosure.

Opening in the front for access

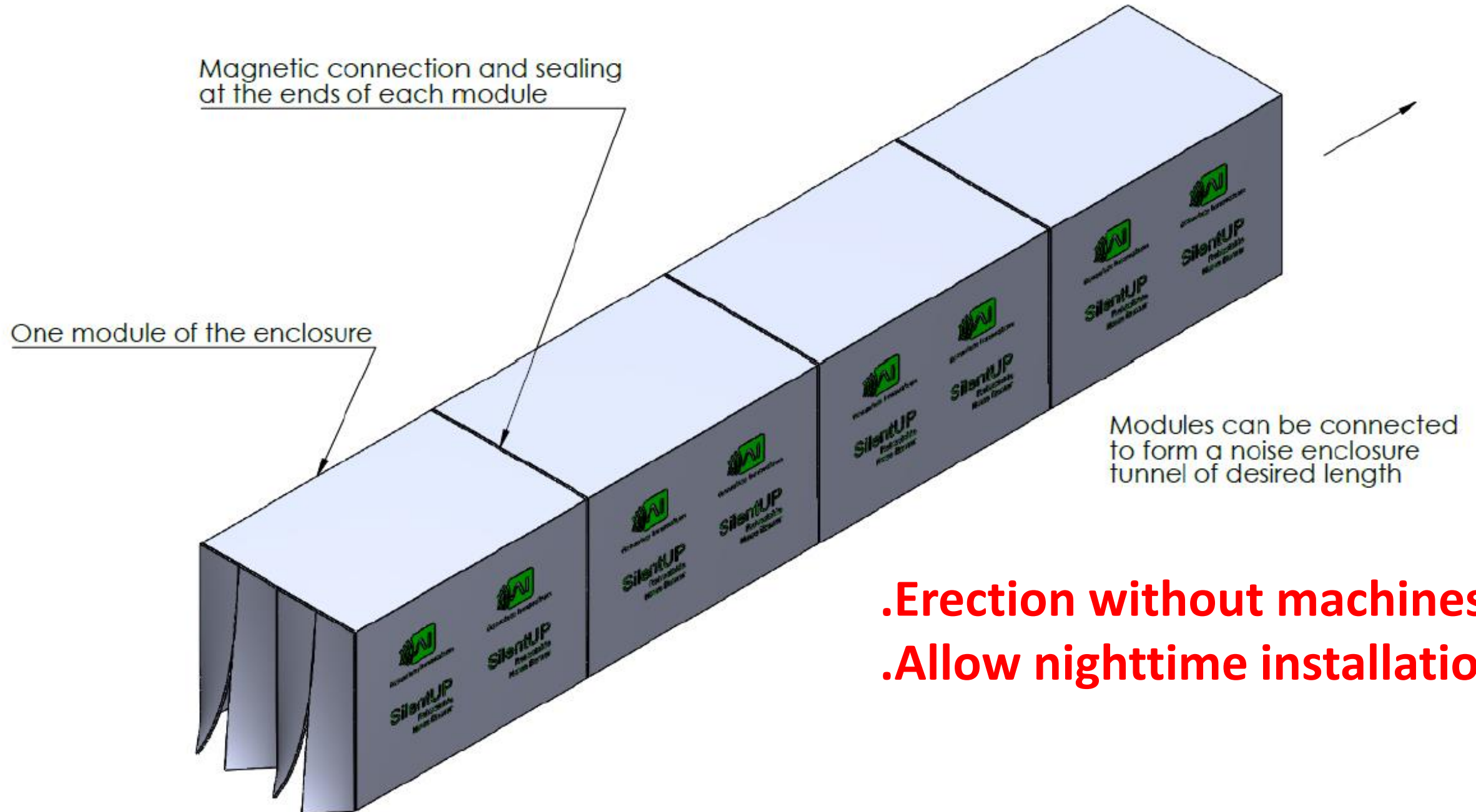
Noise barrier panels at the top and sides



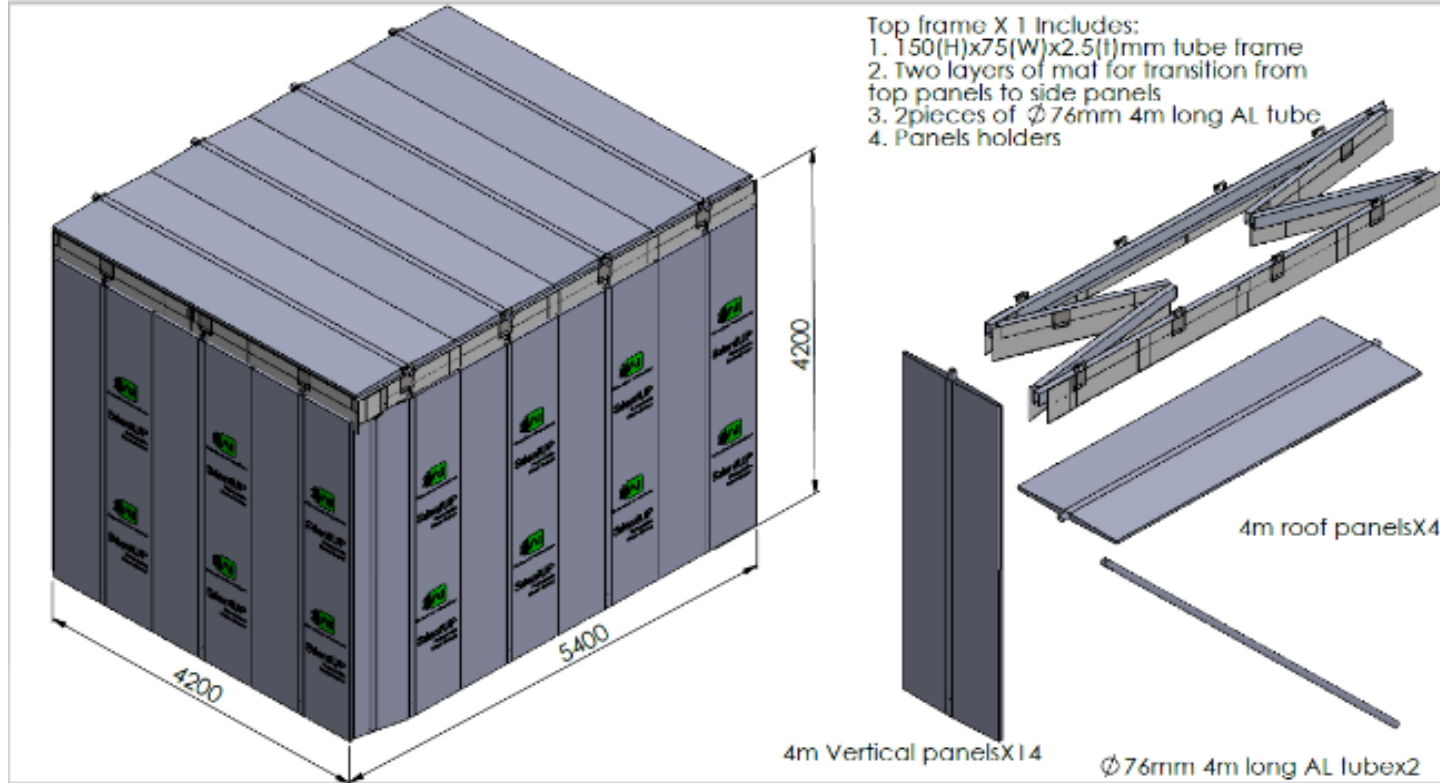
SilentUP
(STC18)

SilentUP
(STC18+acoustic
absorptive layer)

B2. Lightweight Long Enclosure (Prototype not yet used)



B2. Lightweight Long Enclosure (Prototype not yet used)



- HKSAR ITC funded project
- 5.4m x 4.2m x 4.2m prototype enclosure



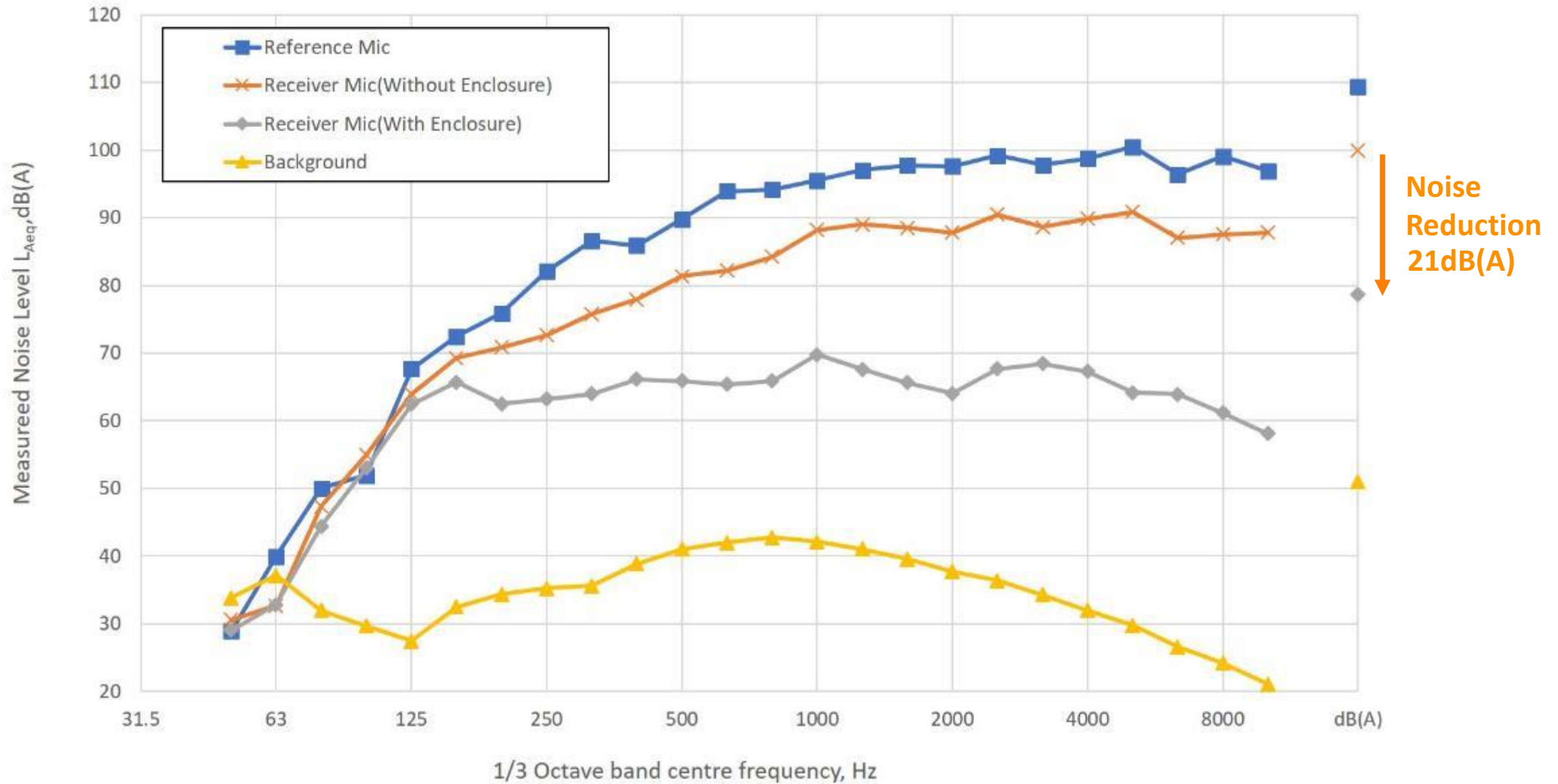
B2. Lightweight Long Enclosure (Prototype not yet used)



5.4m x 4.2m x 4.2m internal view



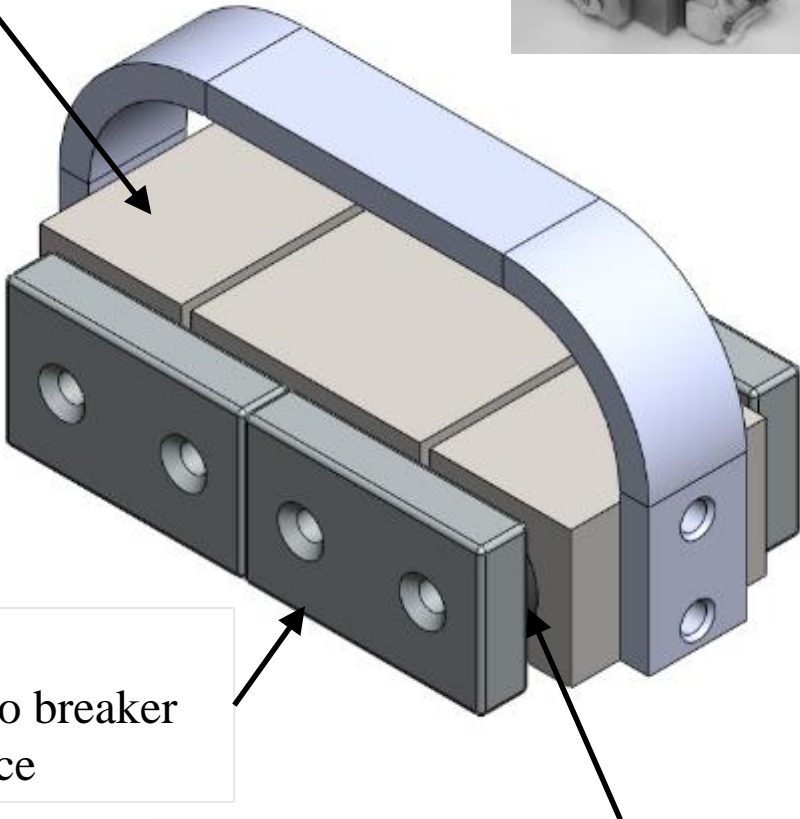
B2. Lightweight Long Enclosure (Prototype not yet used)



B3. Magnetic Tuned Mass Damper (MTMD)



Oscillation mass
- Tuned oscillation frequency to match with structure resonant frequency



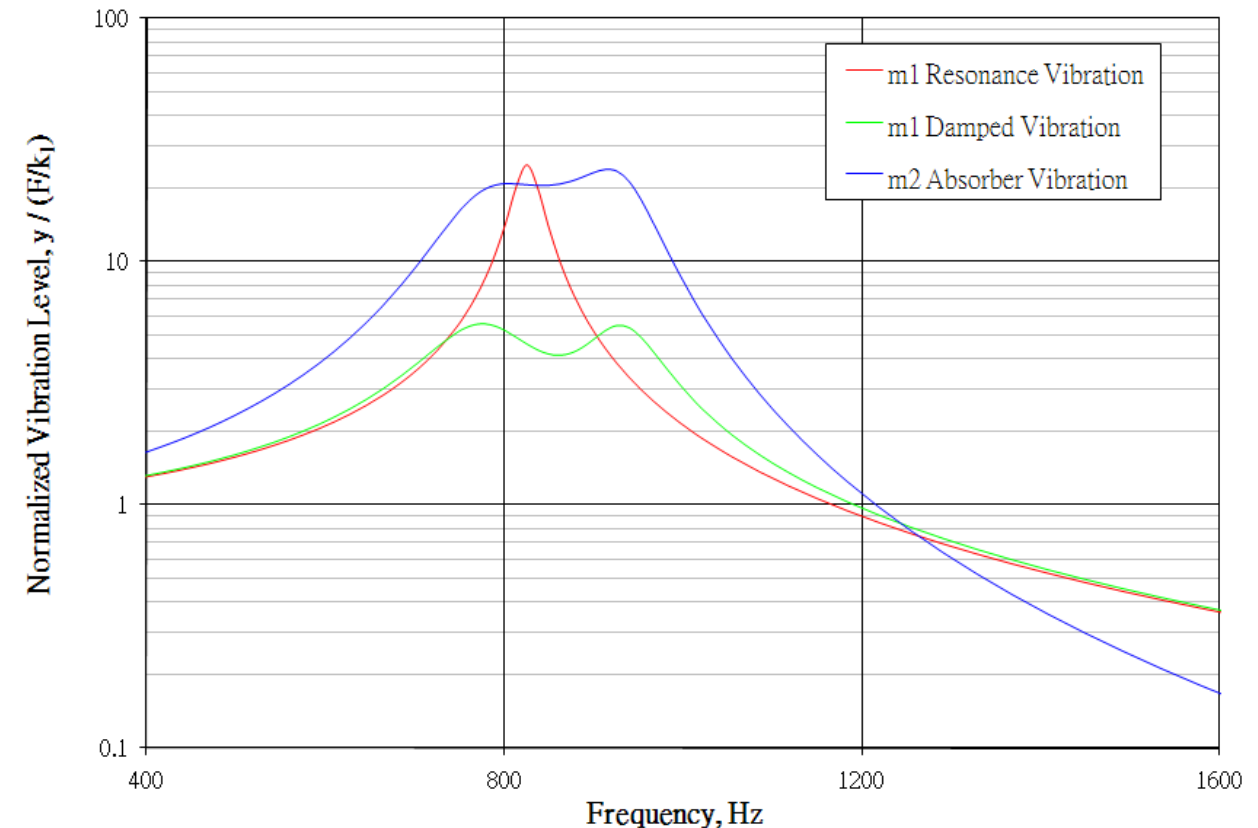
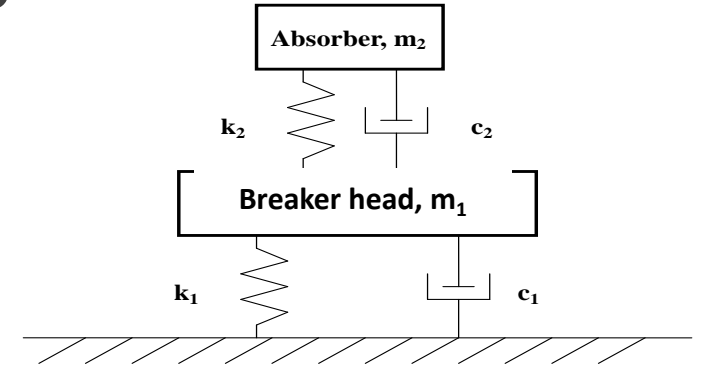
Magnet
- connect to breaker head surface

Resilient layer
- Vibration energy of oscillation mass dissipate energy at resilient layer



Tuned Mass Damping Working Principles

1. Use small mass to reduce vibration resonance at structure
2. Effective for light-damping structure, such as metal casing
3. Frequency tuning to structure resonance is important
4. Strong damping but narrow band

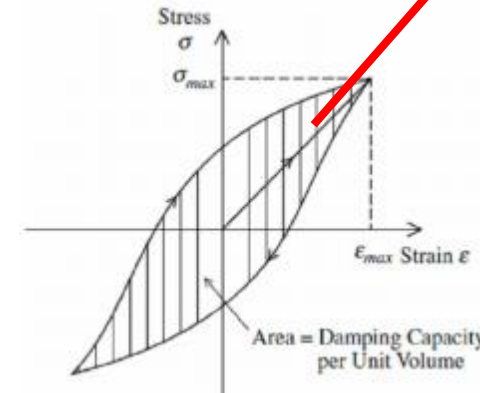


B3. Hydraulic Breaker Magnetic Tuned Mass Damper (MTMD)

Noise reduction due to vibration reduction by hysteresis
(energy dissipation \propto hysteresis loop area)

- All dampers use visco-elastic damping for hysteretic energy dissipation **(weak but broadband)**.
- Our dampers also include MTMD to amplify hysteretic energy dissipation **(strong but narrow band)**
- Require rigid mounting interface **(metal-to-metal contact by magnet)**

Amplified by Tuned Mass Damper (TMD) mechanism



Typical hysteresis loop.
Source: Witos & Stefaniuk 2011.

hysteretic energy dissipation

Energy dissipation increased by 25 to 60 times by TMD



B3. Hydraulic Breaker Magnetic Tuned Mass Damper (MTMD)

Tseung Kwan O



Tseung Kwan O - Lam Tin Tunnel (TKOLTT)

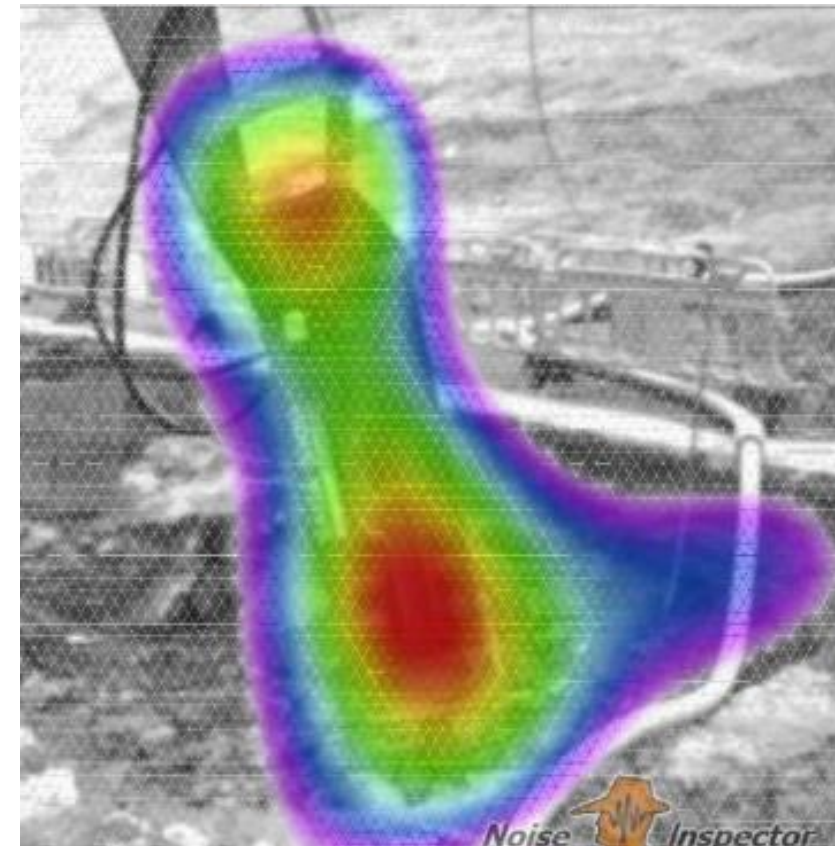
B3. Hydraulic Breaker Magnetic Tuned Mass Damper (MTMD)

- Hydraulic Breaker SWL: 122dB(A)*

(*EPD Technical Memorandum)

Major noisy part

1. Mechanical joint noise
2. Impact head casing noise



B3. Hydraulic Breaker Magnetic Tuned Mass Damper (MTMD)

Magnetic Tuned Mass Damper
used in TKOLTT (2017)



Magnetic Tuned Mass Damper
used in CKR HMT (2020)



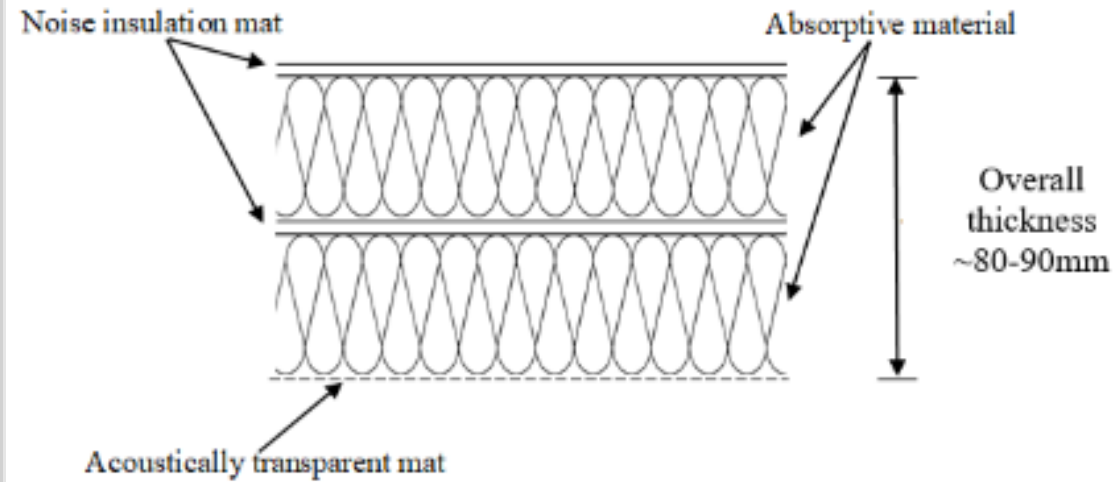
B3. Hydraulic Breaker Magnetic Tuned Mass Damper (MTMD)



B3. Noise Reduction by MTMD & Acoustic Blanket



- Acoustic blanket (SilentMAT)
 - Multi-layer noise barrier mat
 - ~80mm thick absorptive infill



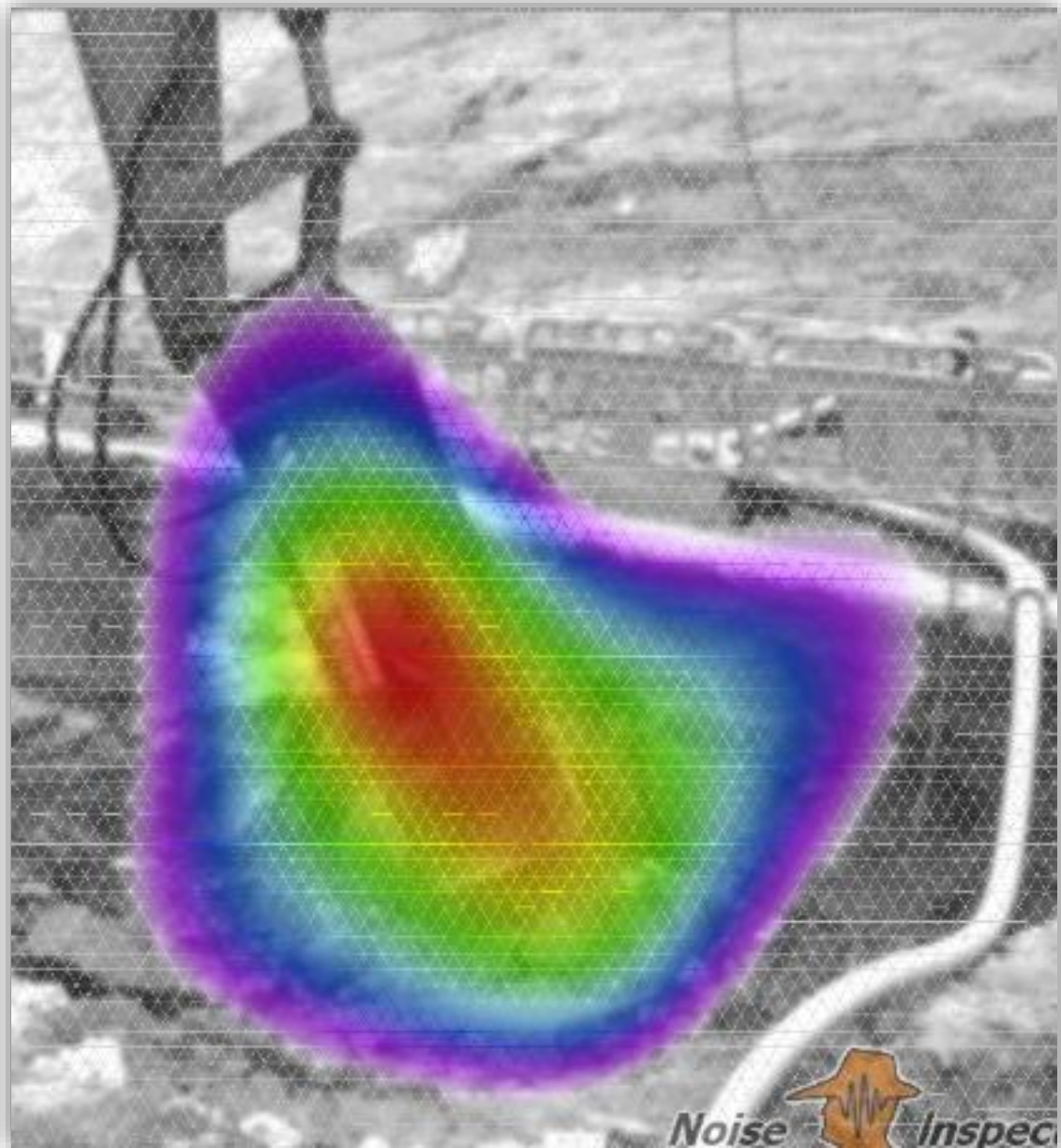
B3. Hydraulic Breaker Magnetic Tuned Mass Damper (MTMD)



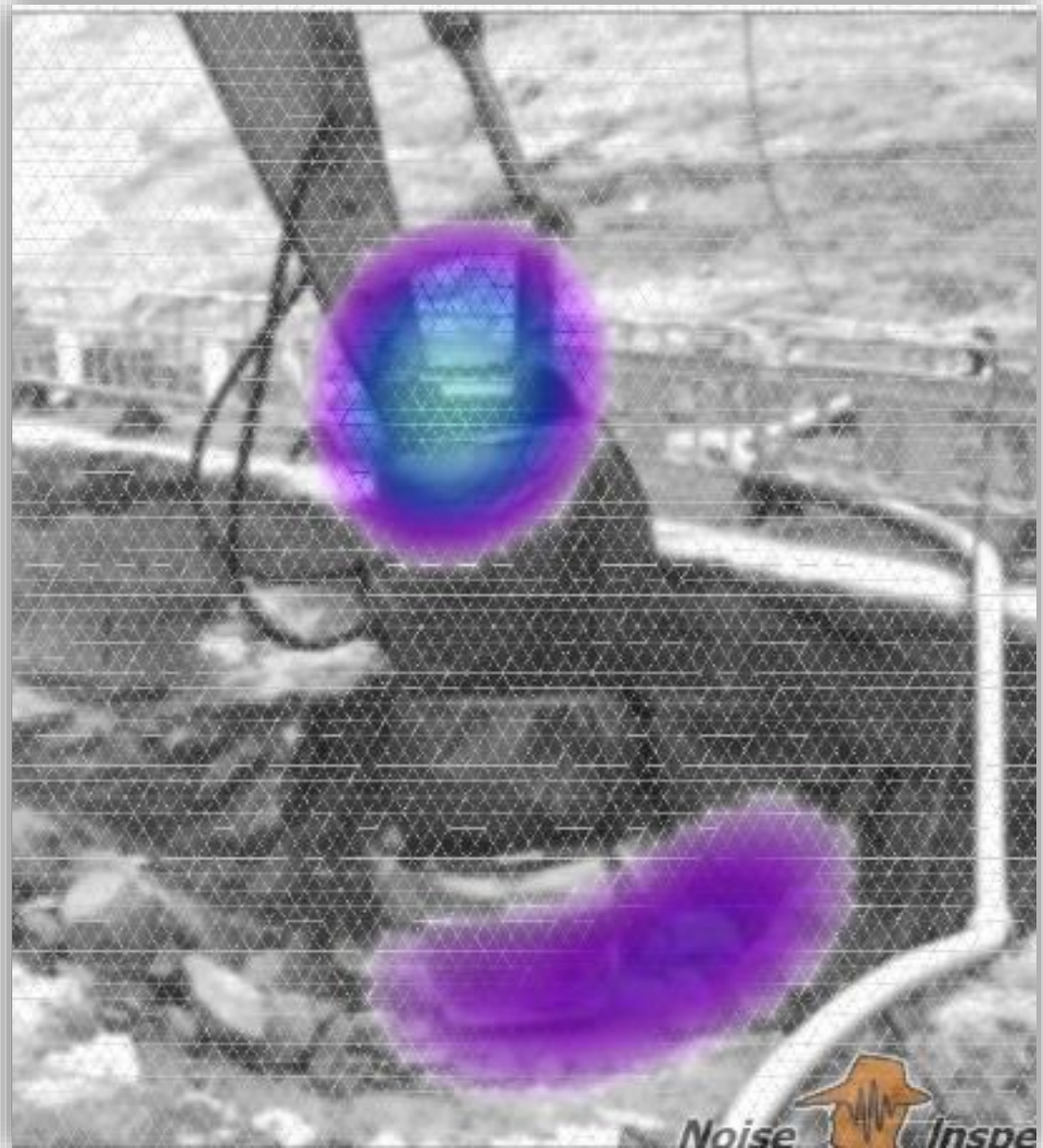
Noise Data Comparison
Before and After
Damper and Acoustic Blanket

Operation Phase		Starting, $L_{Aeq, 5s}$	Stable, $L_{Aeq, 15s}$	Overall, $L_{Aeq, 30s}$
Without mitigation	Averaged Noise Level	97.8	96.4	96.8
Tuned Mass Damper attached	Averaged Noise Level	96.3	93.7	94.2
	Insertion Loss	1.5	2.7	2.6
Tuned Mass Damper and SilentMAT	Averaged Noise Level	95.0	90.7	91.8
	Insertion Loss	2.8	5.7	5.0

Acoustic Camera Results Before Noise Mitigation Measures (Stable Phase)



Acoustic Camera Results After Noise Mitigation Measures (Stable Phase)



B3. Hydraulic Breaker Magnetic Tuned Mass Damper (MTMD)

Magnetic Tuned Mass Damper
used in TKOLTT (2017)



Magnetic Tuned Mass Damper
used in CKR HMT (2020)



B3. Hydraulic Breaker MTMD, CKR HMT Shaft (2020)



B3. Sheet Piling MTMD - Tung Chung New Town Extension



Major noisy part

Reradiated noise from sheet pile vibration



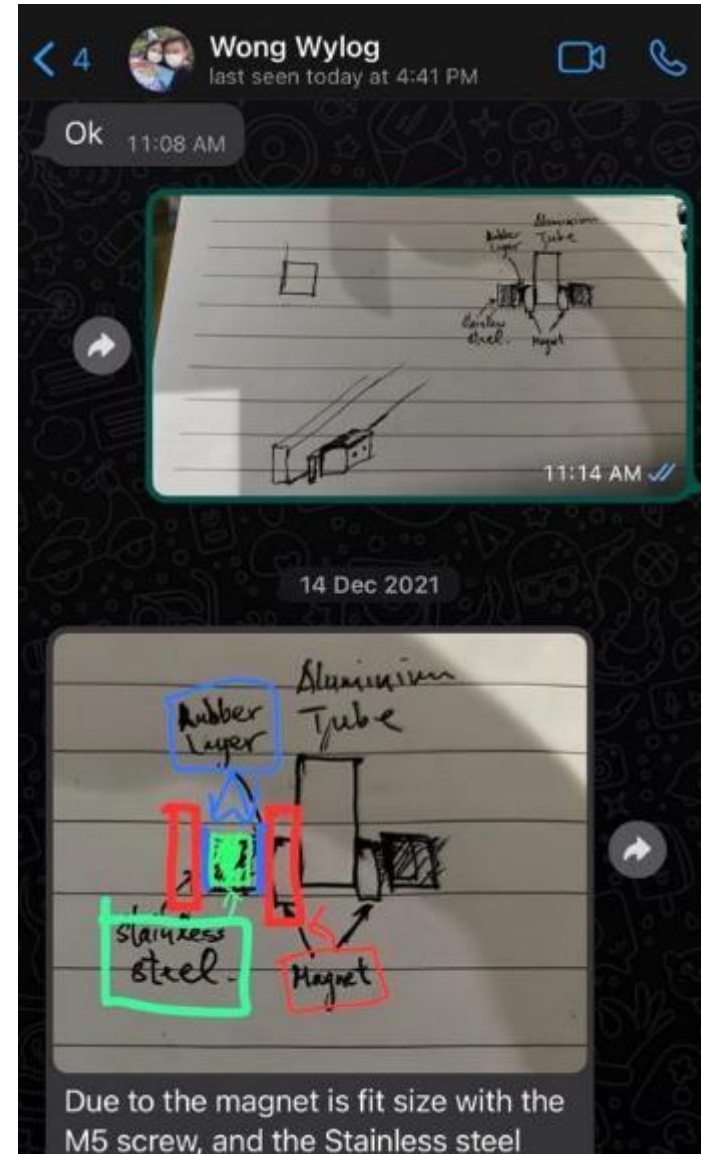
B3. Sheet Piling Noise Reduction by MTMD (2022)

Inside Story: From design to installation within 4 weeks

In December 2021, in UK, I received a video showing excessive noise coming sheet piling process. I was asked if there is any product to reduce the noise.

Based on previous prototype tests on **hydraulic breakers** and **percussive H-beam piling**, we were confident that Magnetic Tuned Mass Dampers (MTMD) will be suitable for this case. Then I sketched a few drawings to Wylog on 14 Dec 2021.

Wylog and Dominic did a fantastic job. The new invention product MTMD was installed on site on 9th Jan 2022. Thank you to Wylog and Dominic.



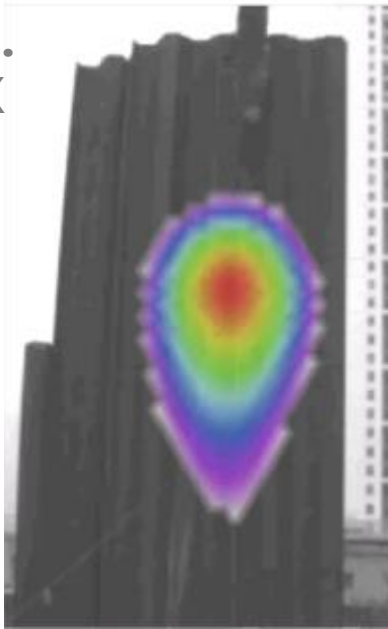
B3. Sheet Piling Noise Reduction by MTMD Solution - Inside Story



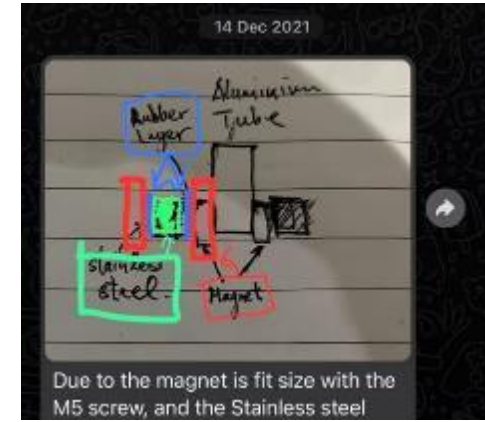
Get video and be asked:

Any product to reduce excessive noise coming from sheet piling process

Early Dec. 2021, UK

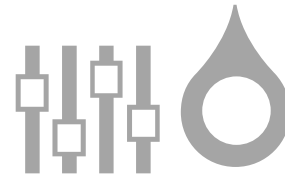


14th Dec. 2021
Sketches UK→HK



New invention product MTMD installed.

10th Jan. 2021, HK

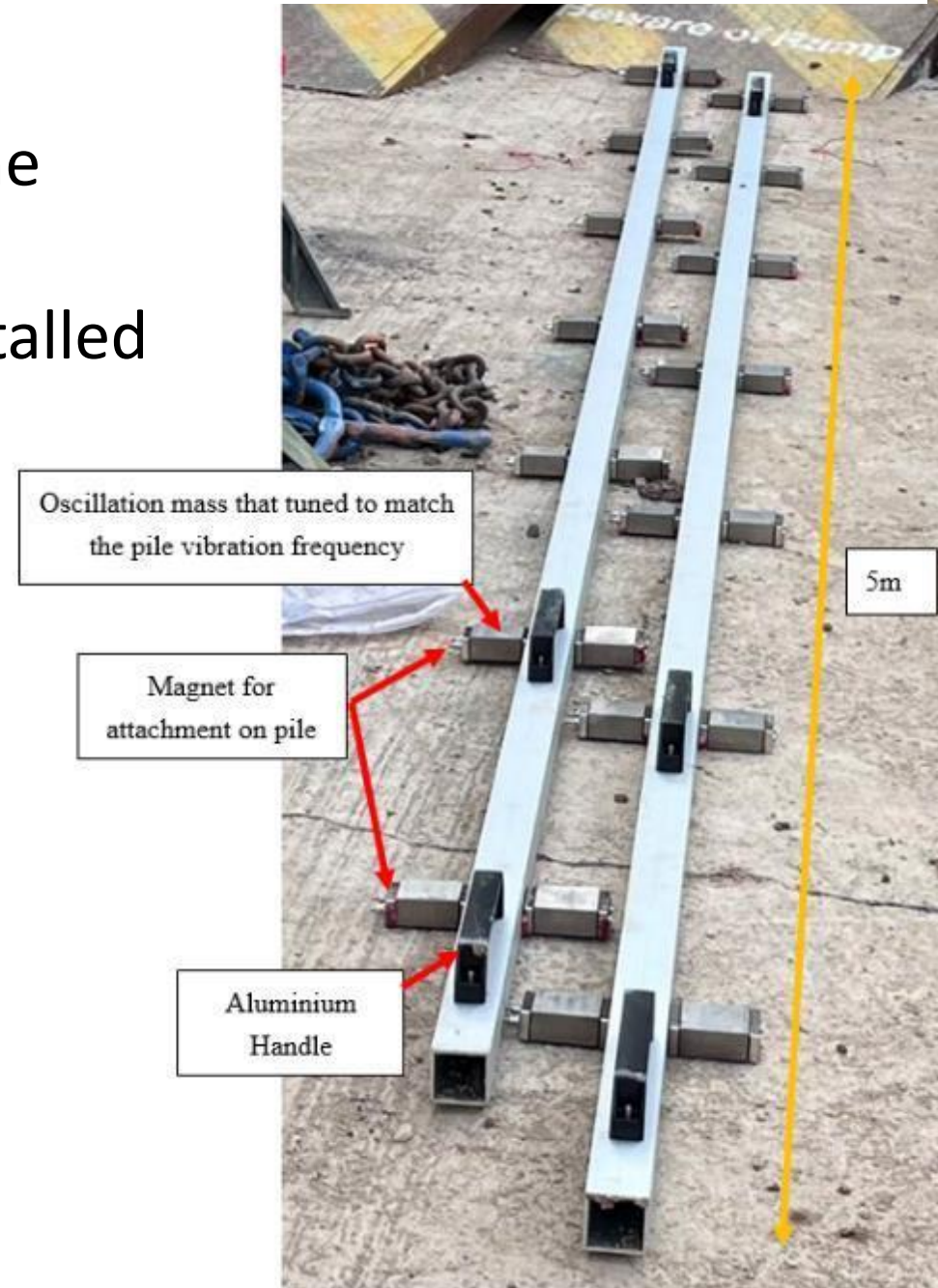


Sketched a few drawings to Wylog.
Be confident that MTMD will be suitable.

From design to installation within 4 weeks

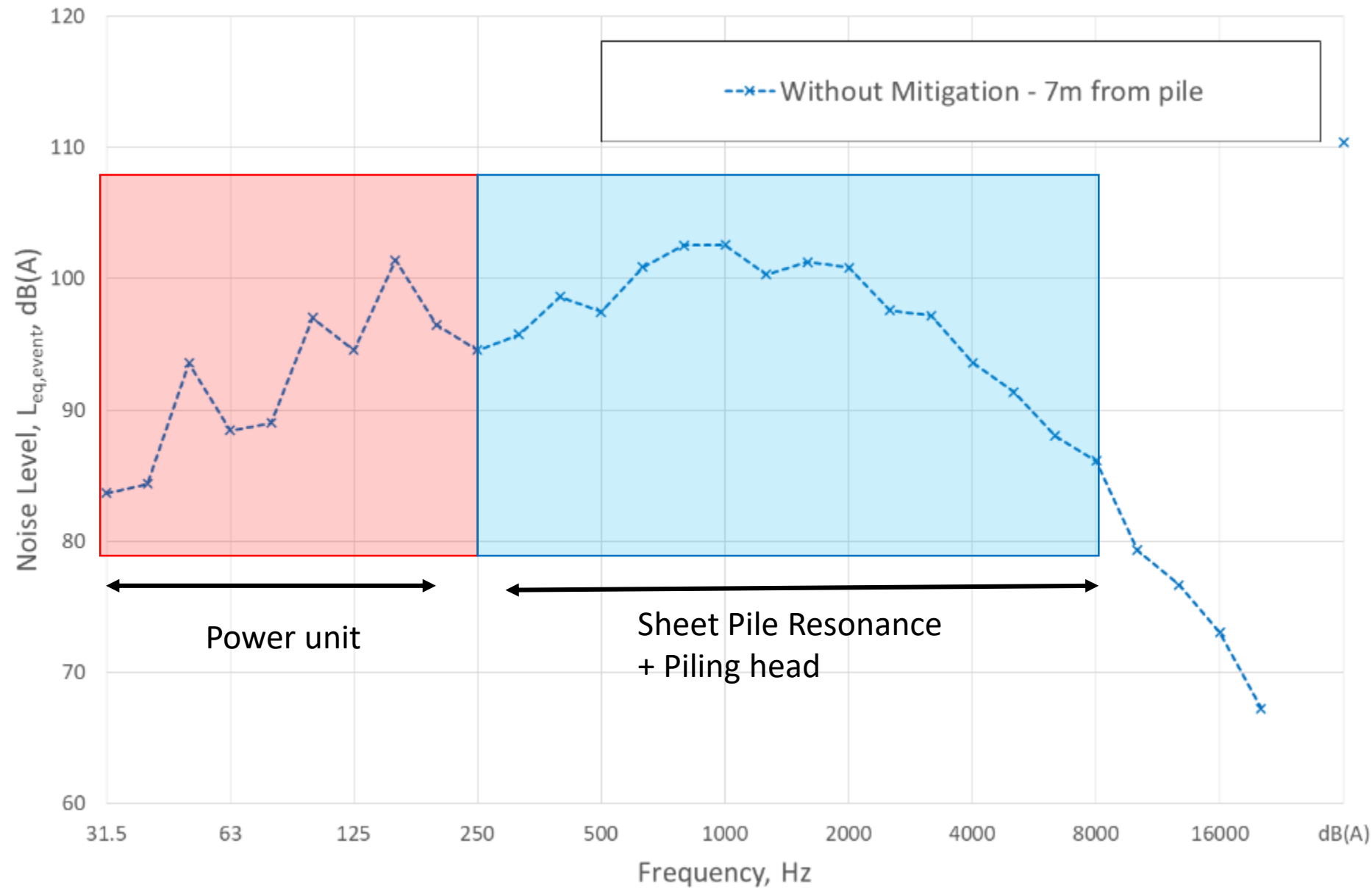
B3. Sheet Piling Noise Reduction by MTMD (2022)

- 6 rows of MTMDs
- Only installed at the adjacent piles
- Driven pile not installed with MTMD





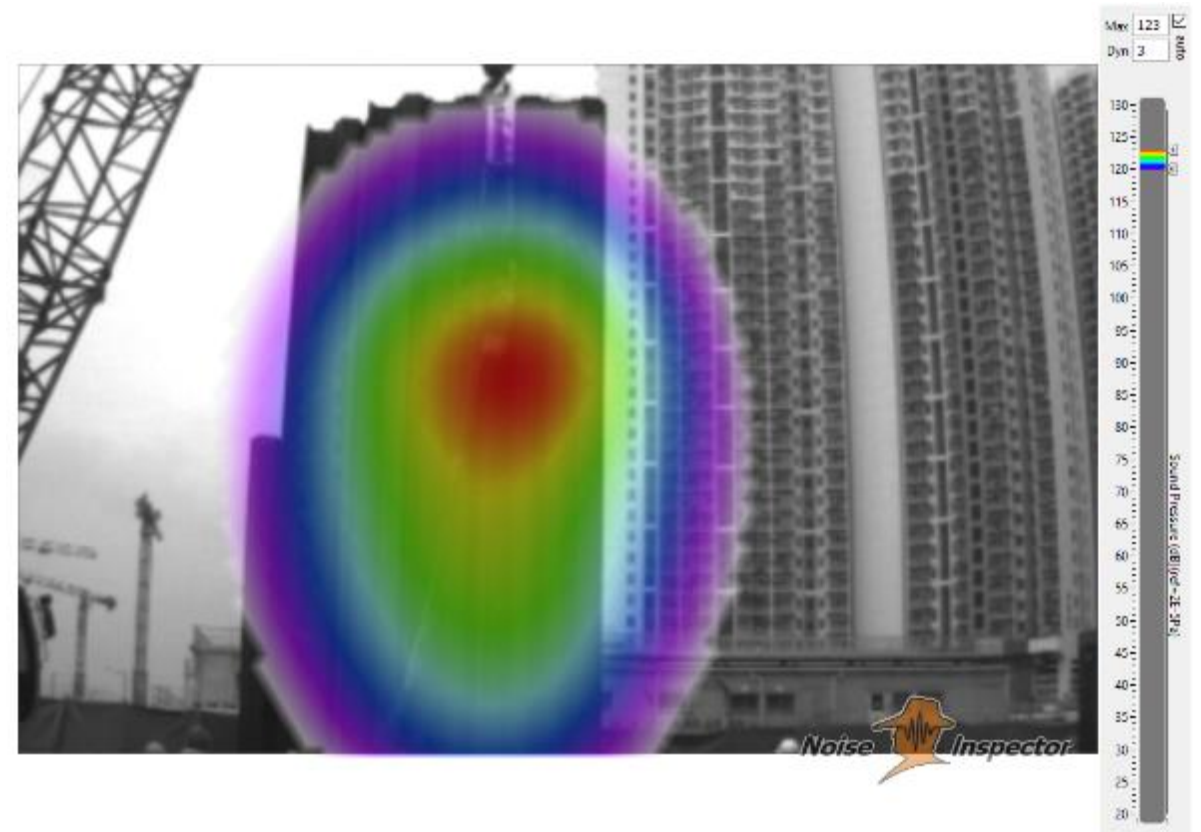
Noise spectrum analysis



Acoustics Imaging



Acoustic image at 65-125 Hz octave.



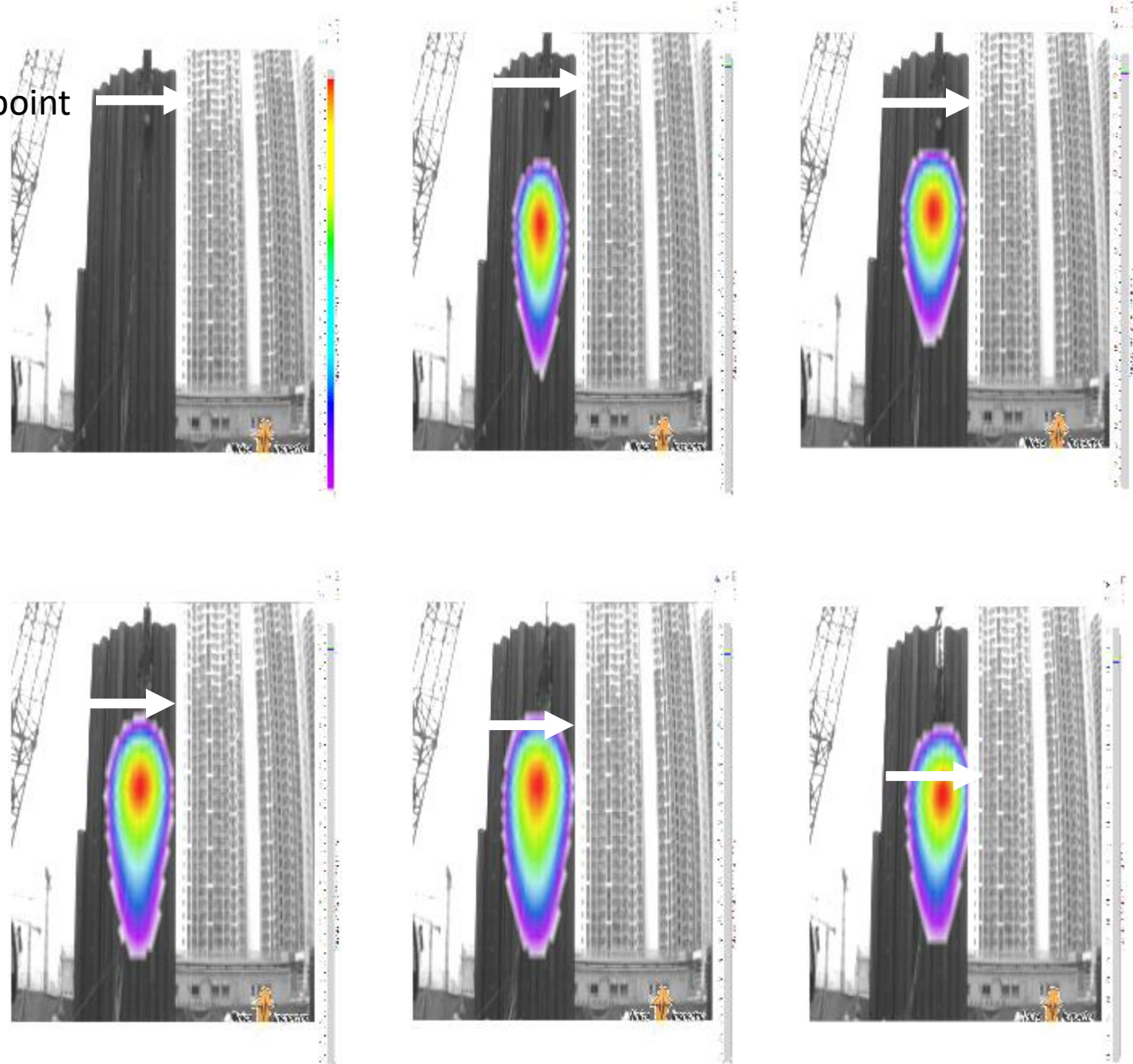
Acoustic image at 500-4000Hz octave at the same time.



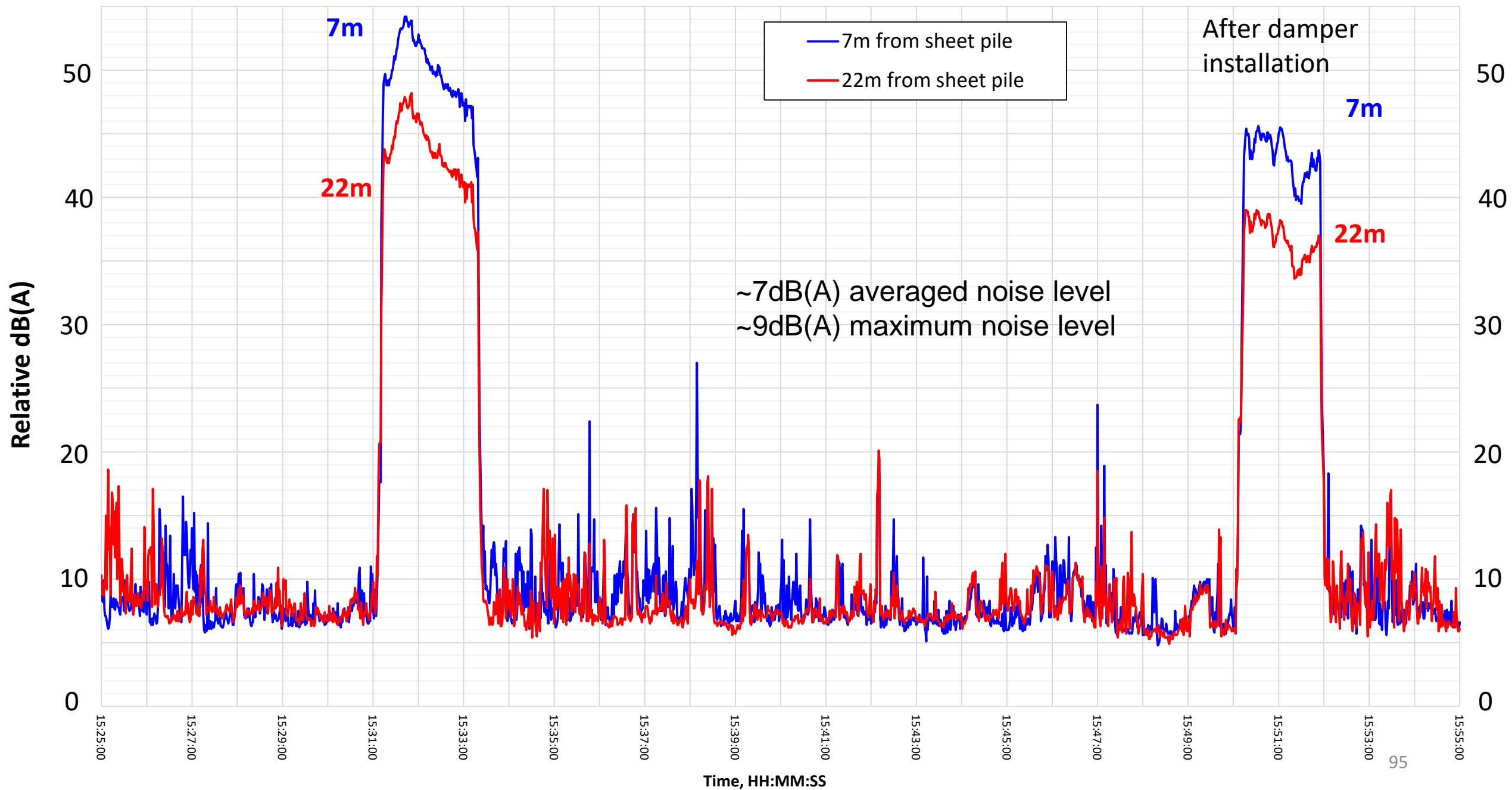
Sheet Pile Vibration Sound Dominates Impact Sound

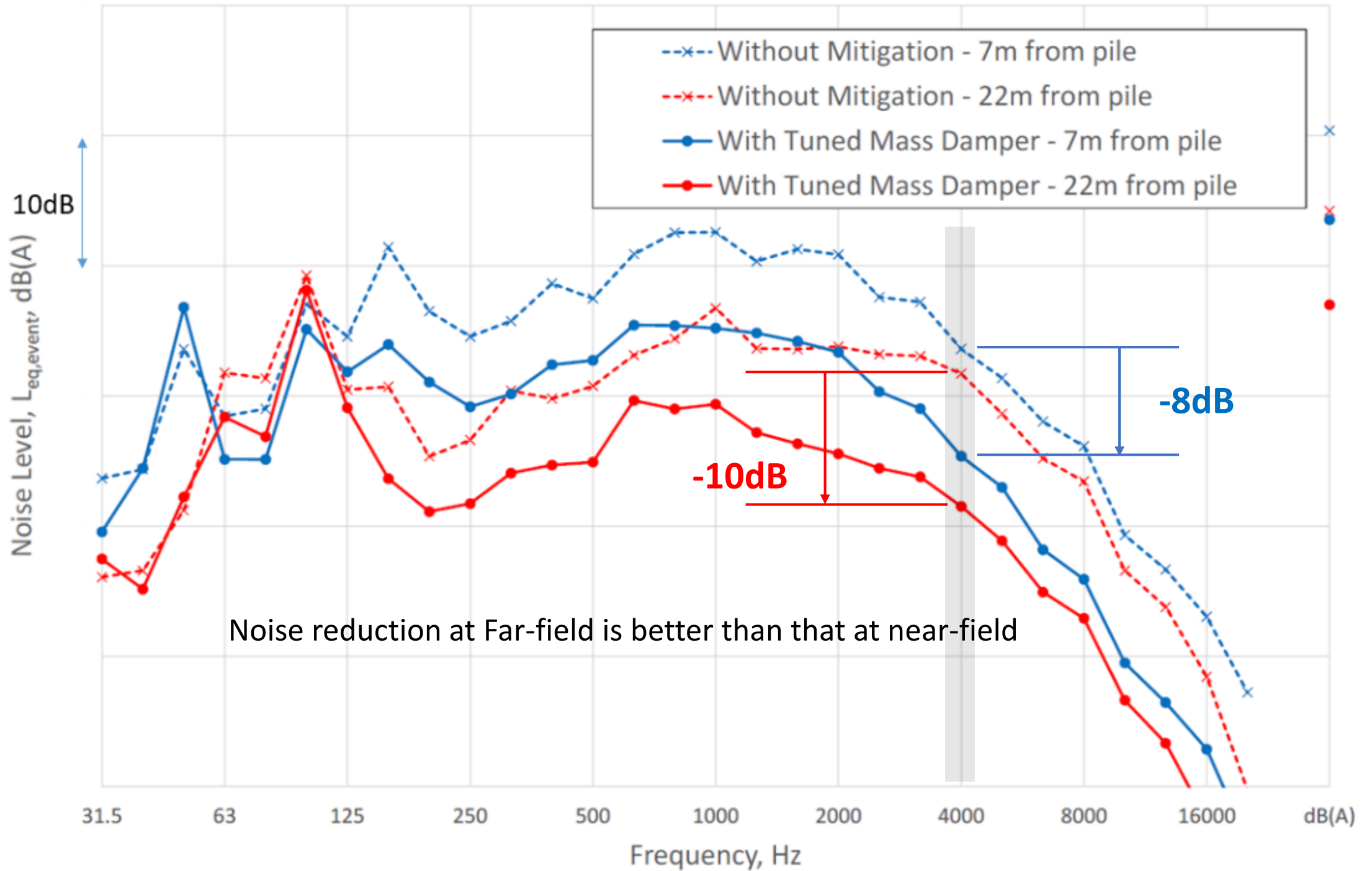
Noise emission
centre nearly
no change in
position

Impact point

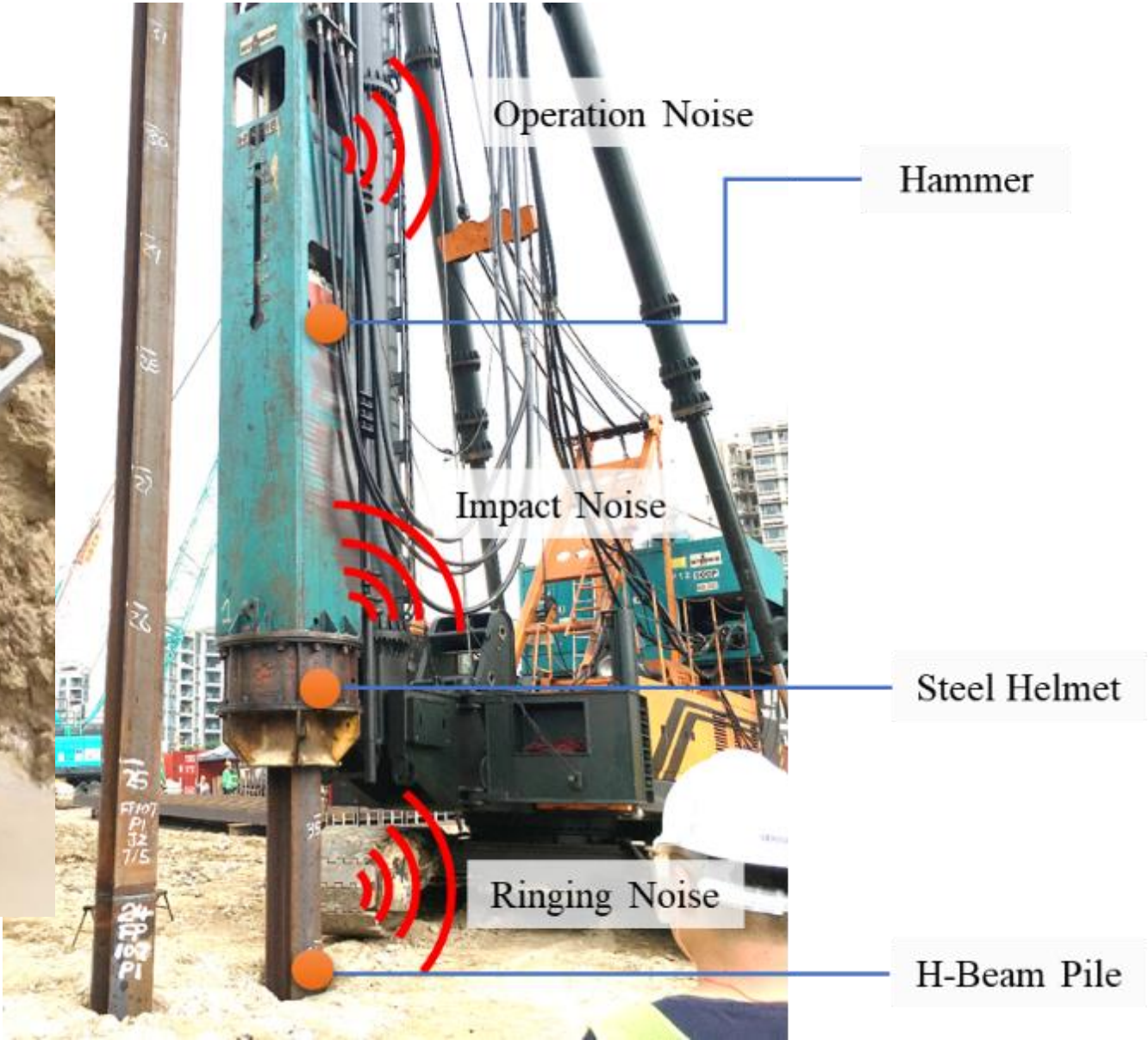


Before damper installation





B3. H-Beam Piling Noise Reduction by MTMD (2017)



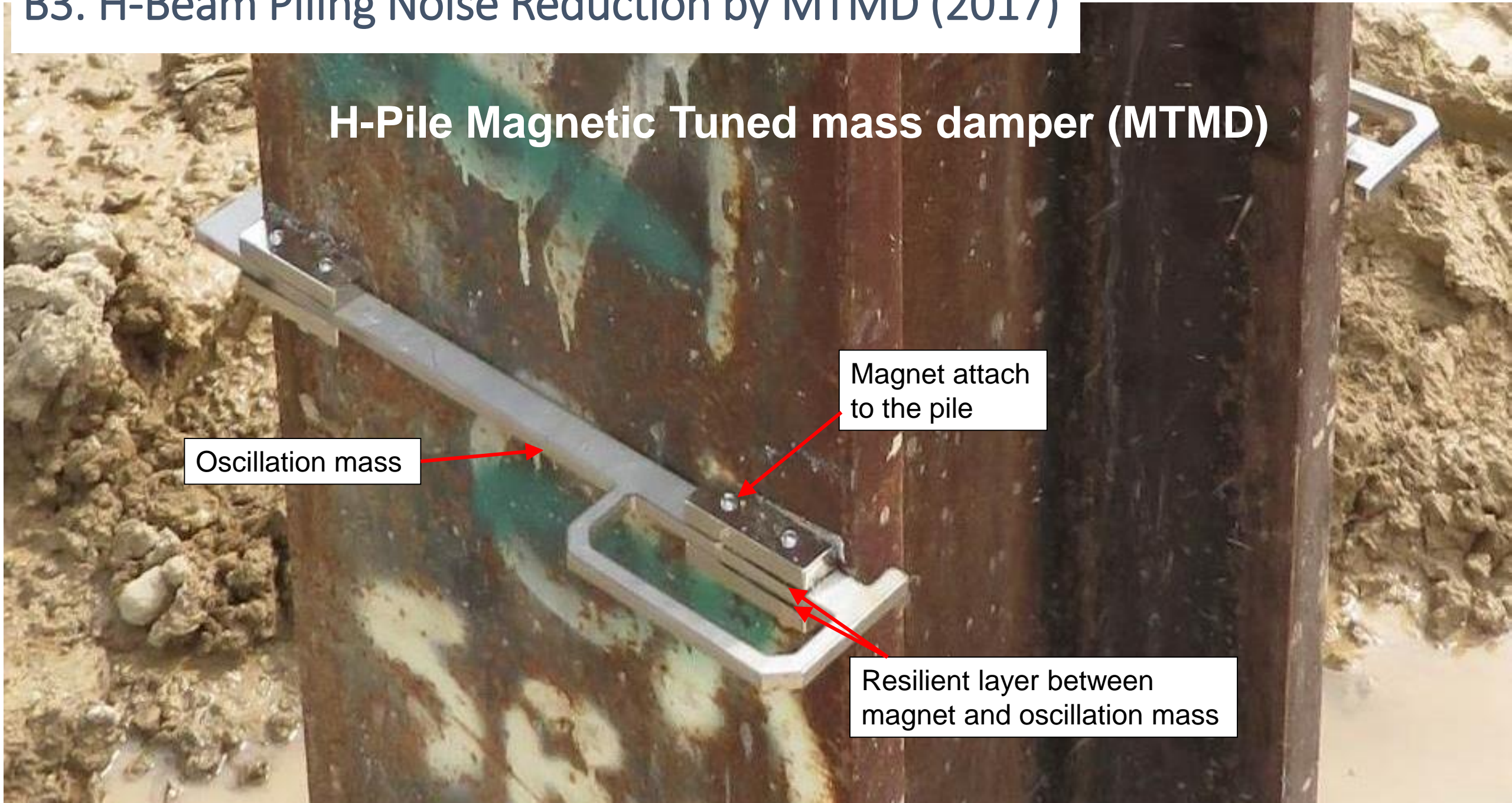
B3. H-Beam Piling Noise Reduction by MTMD (2017)

H-Pile Magnetic Tuned mass damper (MTMD)

Oscillation mass

Magnet attach
to the pile

Resilient layer between
magnet and oscillation mass



B3. H-Beam Piling Noise Reduction by MTMD

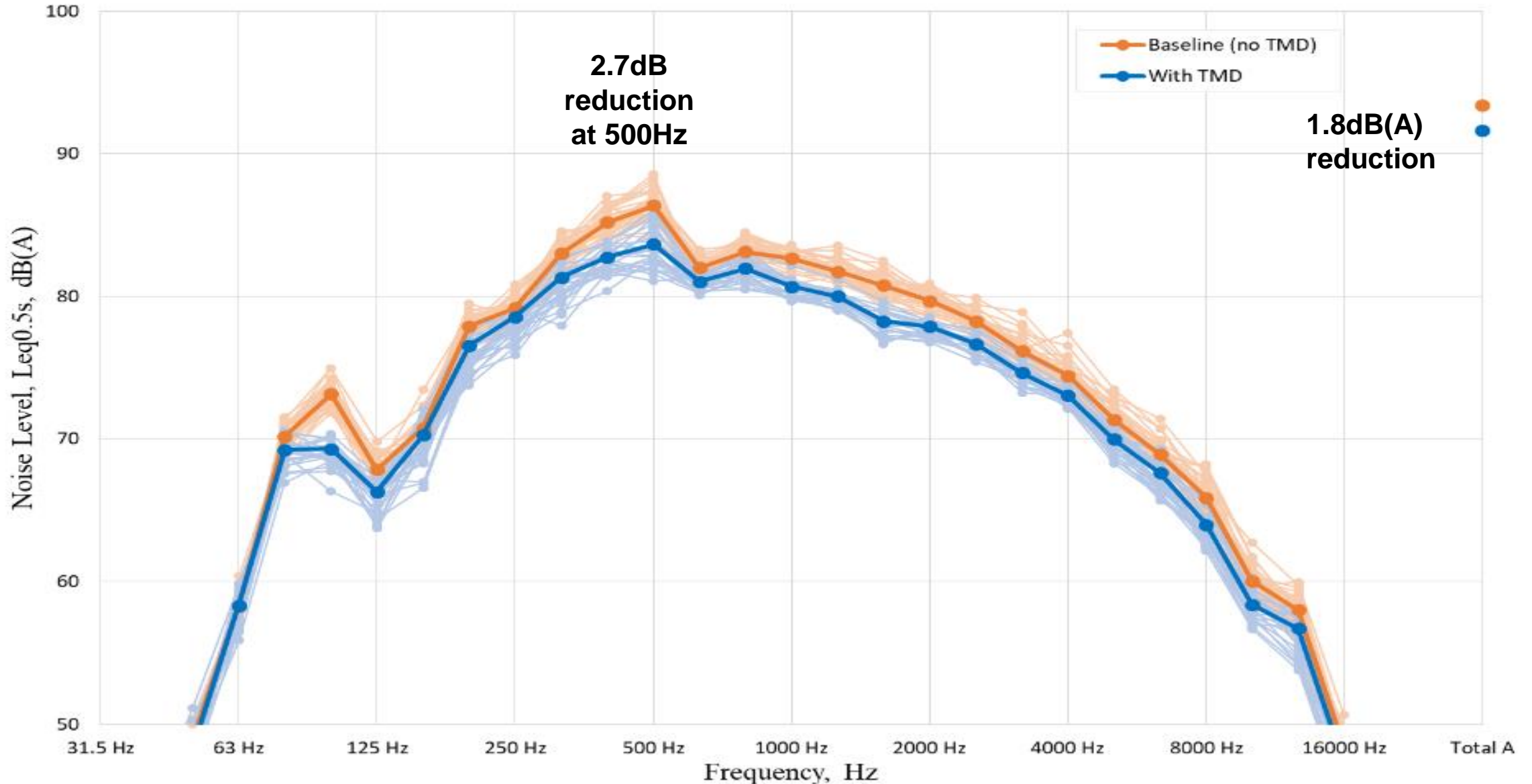
Site trial with a 7.5m long H-Beam

- 14 sets of piling damper on both side of flange with ~1m separation
- 0.8% in weight
- Pile with 40m below ground, already reaching rock head.
- During test, the pile was not driven down and has strong rebound.



B3. H-Beam Piling Noise Reduction by MTMD

On-site testing with a 7.5m long H-Beam



Construction Noise Control Innovative Cases Sharing

A. Tunnel Projects (Dragon Tsui)

1. Central Kowloon Route (CKR)
2. Trunk Road T2
3. Shatin Sewage Treatment Works to Caverns (STSTWC)
4. Inter-reservoirs Transfer Scheme (IRTS)
5. Liantang / Heung Yuen Wai Boundary Control Point (LTH BCP)

End of Part A

B. Innovative Products (Wilson Ho)

1. Retractable Noise Barrier SilentUP[®]
 - Vertical, Cantilever trial,
 - Movable by trolley
 - Horizontal Opening Cover
2. Lightweight Noise Enclosures
 - Wheeled Enclosure
 - Long Enclosure by Modular Connections
3. Magnetic Tuned Mass Damper
 - Hydraulic Breaker,
 - Sheet Piling
 - H-Piling

End of Part B



Thank You

Q&A

Chair by: Mr. Simon Wong of Dragages HK
(Environmental Manager)

Speakers: Mr. Wilson Ho, who@wal.hk
Mr. Dragon Tsui, dragon.tsui@wal2.hk

Please feel free to contact us if you have further queries.

