Tuen Mun - Chek Lap Kok Link
Northern Connection Sub-sea Tunnel Section
Contract No. HY/2012/08

PLAN

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Document Title:

ACOUSTIC DECOUPLING MEASURES PLAN

	PREPARED BY:	INTERNAL REVIEW:			INTERNAL APPROVAL
COMPANY	DBJV	DBJV	DBJV	DBJV	DBJV
NAME	C.F. KWONG	Timothy CHENG	Ivan CHAU	David WESTWOOD	Seved ROBIN
POSITION	Environmental Manager/Officer (EO)	Safety & Environmental Manager	Deputy Project Manager	Project Manager	Project Director
SIGNITURE					
DATE	9 Oct. 2013	9.10.13	10/10/13	10-10-13	10-10-13

(I) DOCUMENT STATUS

Details of Revision:

Revision	Rev. Date	Sections	Amendment Source and/or Details
A	30 Aug 2013	All	Issued for Approval
B	23 Sep 2013	All	Revised for Approval
C	24 Sep 2013	4, 5	4(i) – Updated table 2 5 – updated general notes of installation measures
D	8 Oct 2013	2 (vi), 4 (ii), Appendix C	2(vi) - Only generator will be use on the vessel. 4(ii) – update 4(ii) clause App. C – add typical drawing for acoustic decoupling measures

Status of Page Revision:

Rev. ⇨ Section ⇩	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	X	X																			
2	X	X		X																	
3	X	X																			
4	X	X	X	X																	
5	X	X	X																		

Rev. ⇨ Section ⇩	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Appendix A	X	X																			
Appendix B	X	X																			
Appendix C			X																		

(II) PROJECT DETAILS

Contract no.	:	HY/2012/08
Project Title	:	Tuen Mun – Chek Lap Kok Link, Northern Connection Sub-Sea Tunnel Section
Contract Period	:	From 31st July 2013 to 25th October 2018
The Client	:	Government of Hong Kong Special Administration Region – Highways Department
The Supervising Officer	:	AECOM Asia Company Limited
The Main Contractor	:	Dragages - Bouygues Joint Venture
Nature of Work	:	The design and/or construction for the section of TM-CLKL between Tuen Mun Area 40 and the HKBCF, include the following scope of work:

(i) Design and construction of sub-sea TBM tunnels (two tubes with cross passages) across the Urmston Road, connecting Tuen Mun Area 40 and HKBCF, of approximately 4 km in length with dual 2-lane carriageway (**Figure 1**);

(ii) Design and construction of cut-and-cover tunnels (two boxes with cross passages) at both the southern landfall (**Figure 3**) and the northern landfall (**Figure 2**) for construction of approach roads to the sub-sea TBM tunnels, of approximately 1.5km in length;

(iii) Construction of northern landfall (**Figure 2**) reclamation of approximately 16.5 hectares and about 2.0km long seawalls;

(iv) Design and construction of ventilation buildings at the southern and northern landfalls;

(v) Design and construction of at-grade roads at the southern and northern landfalls;

(vi) Construction of extension of the existing 4-cell box culvert adjacent to RTT;

(vii) Provision of a temporary pontoon for the affected existing Government berths at RTT;

(viii) Design and construction for modification of a section of vertical seawall of approximately 220m in length at the southern landfall (**Figure 3**) to sloping seawall;

(ix) Design and construction of associated civil, structural, building, geotechnical, marine, environmental protection, drainage and sewerage, waterworks and utility works;

(x) Design and construction of advance SEM provisions to facilitate installation of E&M, TCSS and other utilities including tunnel ventilation, tunnel lighting, tunnel fire services, mechanical ventilation & air- conditioning, high voltage power supply, low voltage power supply, fire services, plumbing & drainage, central monitoring & control system and implementation of an EM&A programme for the works under this Contract.

(III) SITE LAYOUT PLAN

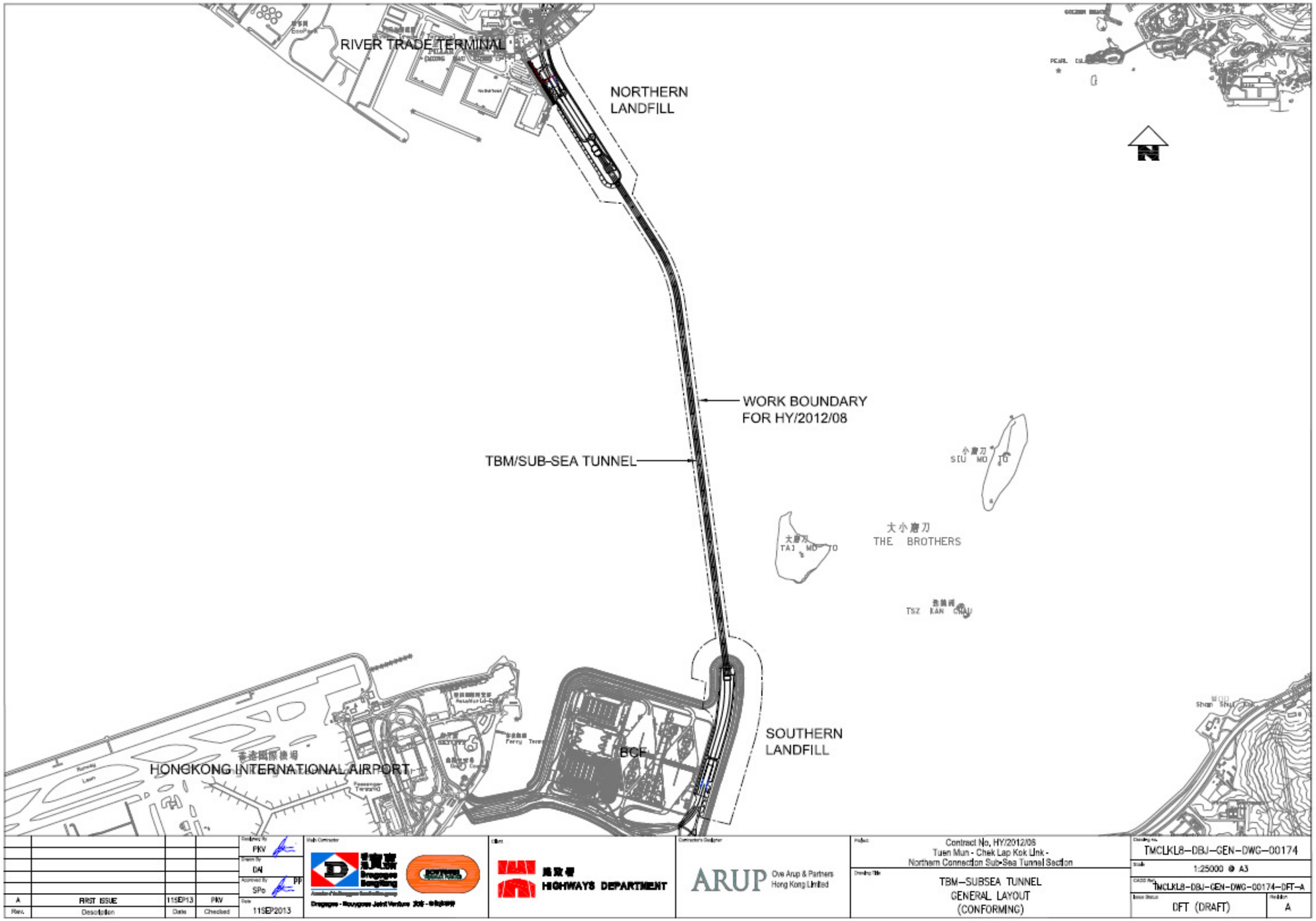


Figure 1 – HY/2012/08 Project

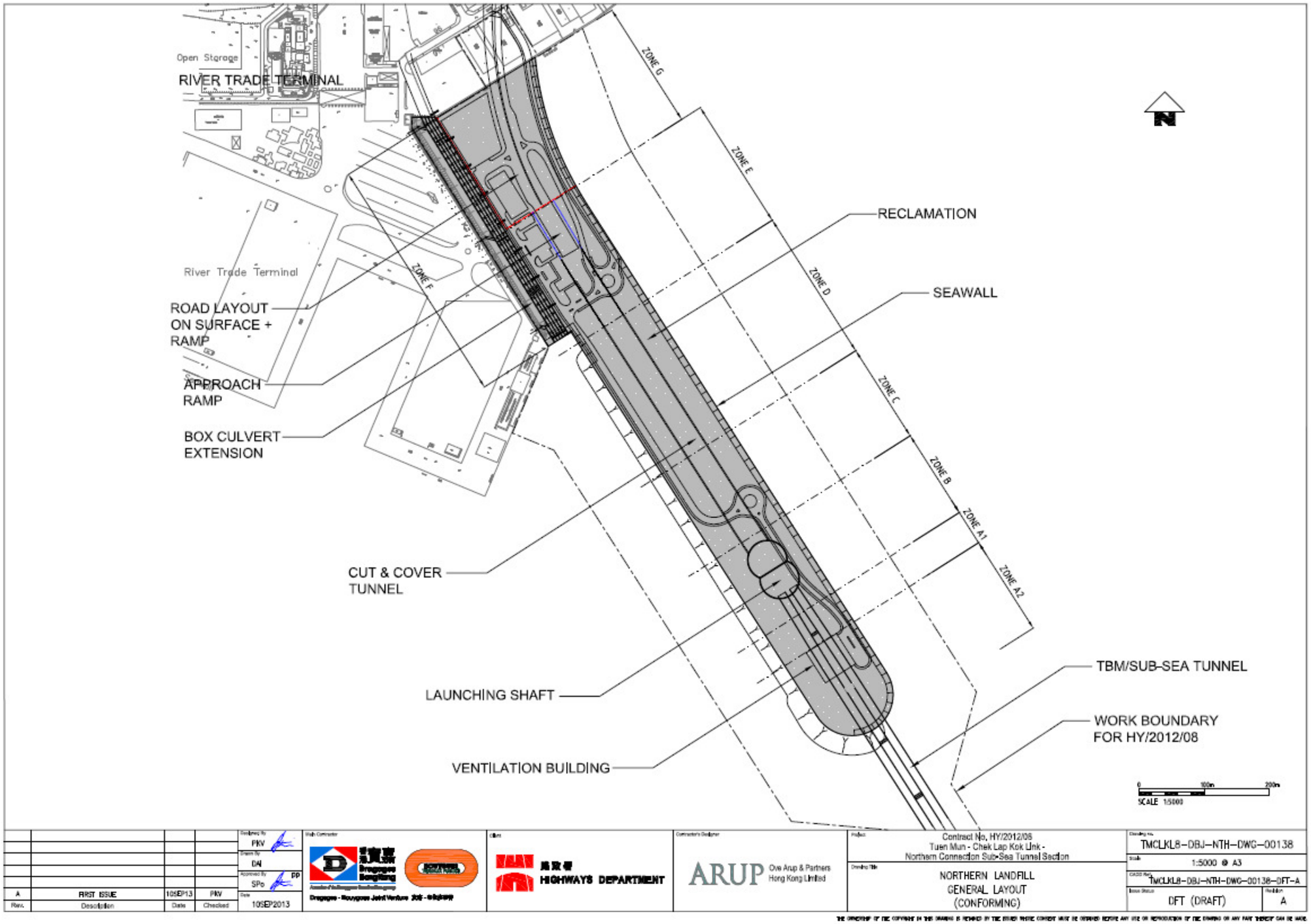


Figure 2 –
Northern Landfall

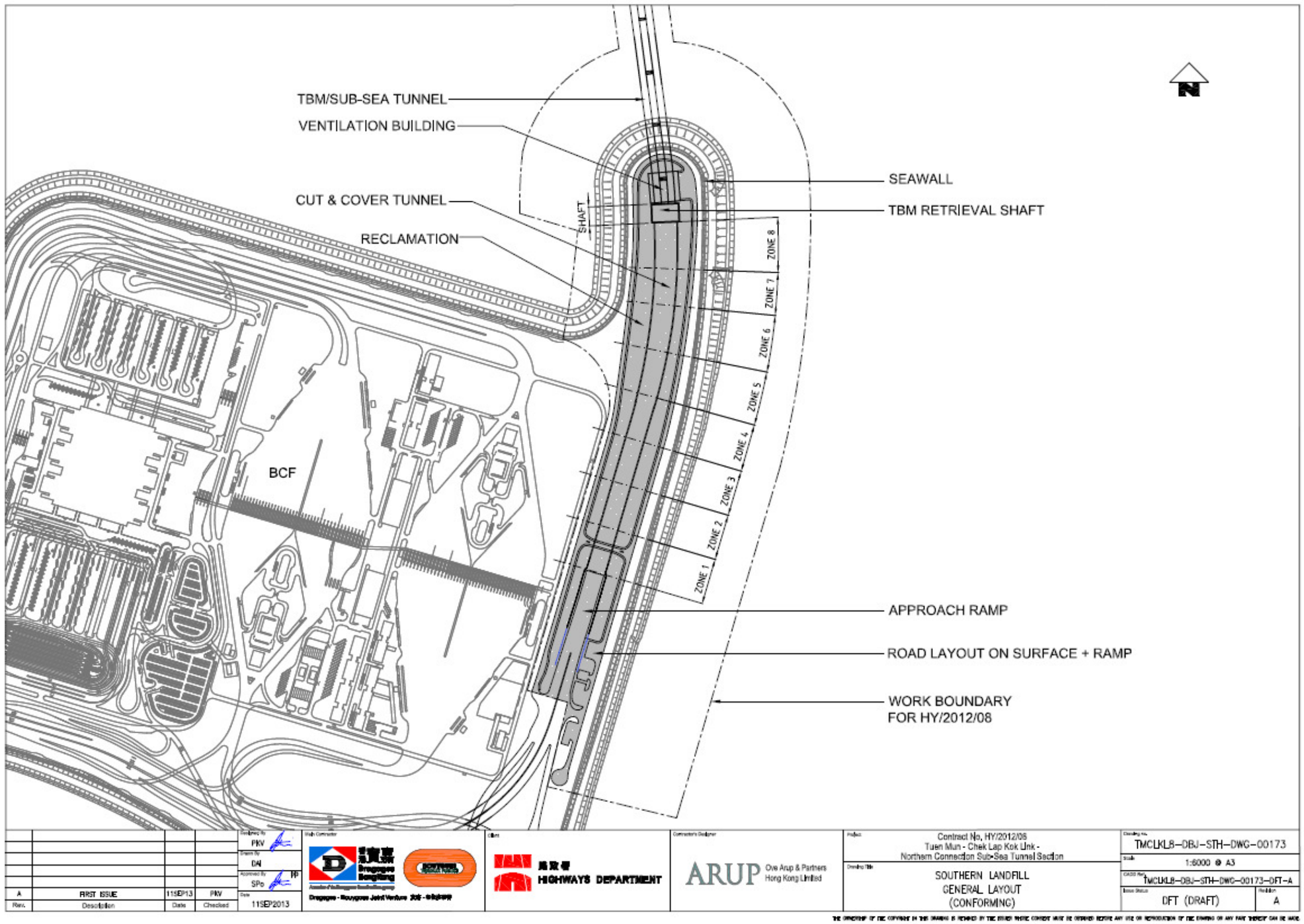


Figure 3 – Southern Landfall

(IV) TABLE OF CONTENTS

1. INTRODUCTION

(i) The Tuen Mun – Chek Lap Kong Link serves to connect Tuen Mun with the Chek Lap Kok and the Hong Kong - Zhuhai - Macau Bridge.

(ii) Highways Department has awarded this Contract to Dragages – Bouygues Joint Venture. Project details are given in Section II above. The Contract scope is depicted in Figures 1, 2 and 3.

(iii) This plan is prepared in accordance with Condition 2.5 of the Environmental Permit (EP-354/2009/A), which requires the Permit Holder to submit to the Director of Environmental Protection the design and implementation of acoustic decoupling measures applied during bored piling, dredging and reclamation works.

2. MARINE CONSTRUCTION NOISE SOURCE

(i) Under the design of the HY/2012/08 Contract, there will be no marine bored piling works and may have limited sheet piling works. The primary marine works will be dredging and reclamation to form the Northern Landfall (**Figure 2**). The Southern Landfall (**Figure 3**) will be reclaimed by others and the sub-sea tunnel (**Figure 1**) will be constructed by tunnel boring machines (TBM), in rocks underneath the marine environment.

(ii) The noise sources from marine works at the Northern Landfall (**Figure 2**), during the construction phase, will mainly comprise of the following activities:

a. Installation of silt curtain;

b. Installation of a temporary seawall, which may be a steel structure, concrete block structure or rock fill. Sheet piling or similar methods may be used;

c. Dredging at the base of load bearing structures and other engineering elements, such as the seawall;

d. Laying geotextile

e. Installation of band drain;

f. Sand and reclamation filling.

(iii) According to Section 8.11.9.29 of the approved EIA Report (Agreement No. CE 52/2007 (HY)), the use of high-frequency sounds by Chinese White Dolphins make them less vulnerable to the effects of dredgers and large vessels, which generally produce very low frequency noises of less than a few kilohertz. These types of vessels are thus not considered to be a significant source of acoustic disturbance and will not be considered as sources of noise and vibration for the implementation of acoustic decoupling measures.

(iv) According to Section 8.14.4.13 of the approved EIA Report (Agreement No. CE 52/2007 (HY)), construction equipment can be noisy and, when such pieces of equipment are used on the water or in coastal waters, some of the sound may be transmitted into water and affect small cetaceans as noise pollution. Air compressors and other noisy equipment that must be mounted on steel piling barge should be acoustically de-coupled to the greatest extent feasible. Section 8.14.4.13 of the EIA Report suggests the use of rubber tires or air-filled tires to de-couple noise (i.e. wheel mounted air compressors or generators are de-couples from the deck).

(v) It is envisaged that there will be 6 types of working vessels working in the Northern Landfall dredging and reclamation area. Some of them are support vessels and will not carry separate noisy equipment. Not all of the noisy equipment will be operated at any one time.

(vi) The noisy equipment allocated on the working vessels is listed in **Table 1**. Only generator will be mounted on the vessels, together with acoustic decoupling measures. No other noisy equipment will be use on board. The photos of the noisy equipment are shown in **Appendix A**. The list will be updated regularly and communicated to the SOR, ETL and IEC/ENPO.

Table 1: Vessel and Noisy Equipment Inventory

Working Vessels	Noisy Equipment on Working Vessels	Expected No of generators
2400T Derrick Barge x 8	Generator, Silenced, 75dB (A) at 7m (Diesel, 35.81kW, 1.5 Tons. Approx.) only installed in 2 nos. of barge	2
850hp Tug Boat x 4	None	0
1000m^3 Split Hopper Barge x 7	Generator, Silenced, 75dB (A) at 7m (Diesel, 35.81kW, 1.5 Tons. Approx.) only installed in 5 nos. of barge	5
Flat Top Barge x 1	Generator, Silenced, 75dB (A) at 7m (Diesel, 35.81kW, 1.5 Tons. Approx.) x 1/barge	1
Grab Dredger x 2	Generator, Silenced, 75dB (A) at 7m (Diesel, 35.81kW, 1.5 Tons. Approx.) x 2/dredger	4
Motor Sampan	No Noisy Equipment, for transportation only	0

3. PROPOSED ACOUSTIC DECOUPLING MEASURES

(i) The same noise isolation pad previously approved in other Hong Kong – Zhuhai – Macau Bridge (HZMB) projects (e.g. Link Road Contracts HY/2011/03, HY/2011/09 and HY/2012/07) is proposed to be used for this Contract. This product was originally developed and marketed as noise dampening underlays for building construction. Product literature of the isolation material is given in **Appendix B**.

(ii) If sheet piling is to be carried out, isolation pads shall be fitted between the vibrator clamp and the sheet pile, such that the path from noisy equipment through the sheet pile to the marine environment is broken.

(iii) The typical set up of the acoustic decoupling measures for the generator and the sheet pile vibrator are shown in **Appendix C.**

4. IMPLEMENTATION OF ACOUSTIC DECOUPLING MEASURES

(i) The dimensions of the proposed isolation pad for the noisy equipment are given in **Table 2.**

Table 2: Vessel and Noisy Equipment Inventory: Footprint Area of Isolation Padding

Proposed Working Vessel	Noisy Equipment Identified on Working Vessel	Envisaged Dimension of Proposed Isolation Pad (LxWxH) Each
2,400T Derrick Barge x 8	Generator (Diesel)	2m x 1m x 30mm approx.
850hp Tug Boat x 4	None	N.A.
1,000m^3 Split Hopper Barge x 7	Generator (Diesel)	2m x 1m x 30mm approx.
Flat Top Barge x 1	Generator (Diesel)	2m x 1m x 30mm approx.
Grab Dredger x 2	Generator (Diesel)	2m x 1m x 30mm each (approx.)
Motor Sampan	None	N.A.

(ii) Only generator will be mounted on the vessels, together with acoustic decoupling measures. No other noisy equipment will be use on board.

(iii) Noisy equipment will be fixed on noise decoupling pads instead of being mounted directly on the deck. The Contractor will ensure the foundation of the equipment is flat and level prior to

installation. Adequate clearance all around the noisy equipment will be kept to avoid vibration transmitted to other materials and machinery.

(iv) Those noisy equipments, such as engines, which are welded directly onto the deck of vessel, should provide other mitigating measures such as alternative work schedule to minimize the vibration transmission to the sea.

5. GENERAL NOTES ON INSTALLATION MEASURES

(i) To forbid direct vibration transmission, adequate plinth clearance shall be kept all around.

(ii) Close all panels or doors of generators when in use.

(iii) To avoid noise breakout and the undesirable sound paths through gaps, the foundation where the equipment to be placed shall be flat and level.

(iv) To further eliminated the sound generation from noisy parts, flexible bellows silencers, mufflers shall be applied when necessary.

END OF CONTENT

APPENDIX A - PHOTOS OF NOISY EQUIPMENT AND PROPOSED WORKING VESSELS

NOISY EQUIPMENT

Generator on vessel board

WORKING VESSELS

2400T Derrick Barge

850hp Tug Boat

	
1000m3 Split Hopper Barge	Flat Top Barge

	
Grab Dredger	Motor Sampan

APPENDIX B - ISOLATION MATERIAL PRODUCT LITERATURE

1. General information of PO-MAT

With forming air layers inside, micro-cellular Polyurethane mat offers good elasticity and is applied in a wide range of dynamic load. In particular, since the load is uniformity distributed in full measure, the thickness of floating slab can be reduced. Noise-insulated active materials whose elasticity is maintained by amt itself, the product does not need Floating slab-ascending work.
The colors can be application to design work

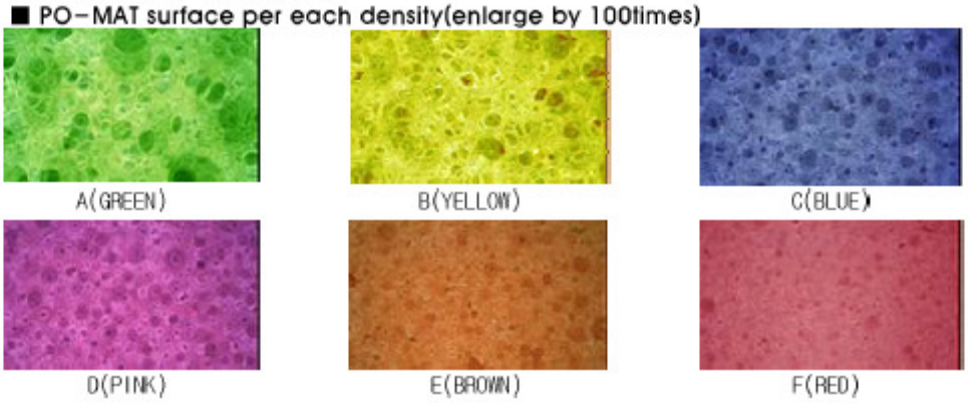
2. PO-MAT Range

Proposed material for the contract

MODEL	A12	A25	B12	B25	C12	C25	D12	D25	E12	E25	F12	F25
THICKNESS	12	25	12	25	12	25	12	25	12	25	12	25
COLOR	GREEN		YELLOW		BLUE		PINK		BROWN		RED	
DENSITY (kg/m³)	150±10		220±10		300±10		400±10		500±10		600±10	
RATED LOAD (N/mm²)	0.007		0.024		0.052		0.1		0.2		0.4	
RATED DEF.(mm)	4.0	8.2	3.6	7.5	3.3	6.8	3.0	6.0	2.8	5.8	2.5	5.2
PRODUCTION VOLUME	Owned Manufacturing Facilities:100~150㎡/Day(8Hrs/Day)											
PRODUCTION SIZE	[1,000mm x 1,000(500)mm x THICKNESS]											
MANUFACTURING PROCESS	1. Pouring Polyol and MDI in a tank. 2.Heating ingrediants. 3.Mix POLYOL and MDI by SHOOTER. 4.Pouring the mixed ingrediants to a mold as suitable density. 5.Forming. 6.Removing mold and scraps. 7.Work condition:1)regulare heating temperature, air pressure and mold temperature, 2)regular forming time											

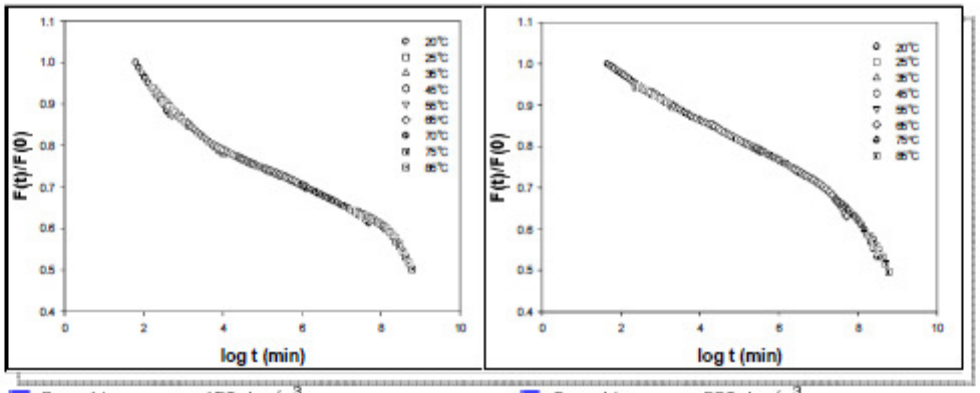
3. Durobility Test Result

■ PO-MAT surface per each density(enlarge by 100times)



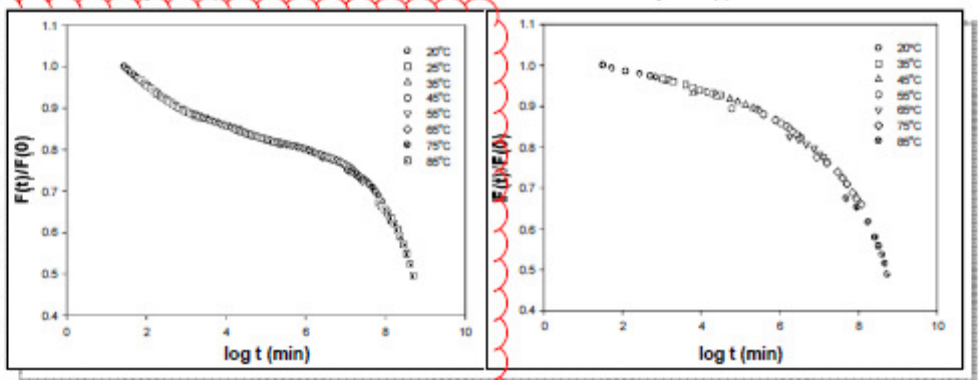
■ Durability tes by TTS(Time-Temperature Superposition)

■ Resposibility: Ph.D Yungwook, Jang, Chemical Engineering, Hanyang Univ.



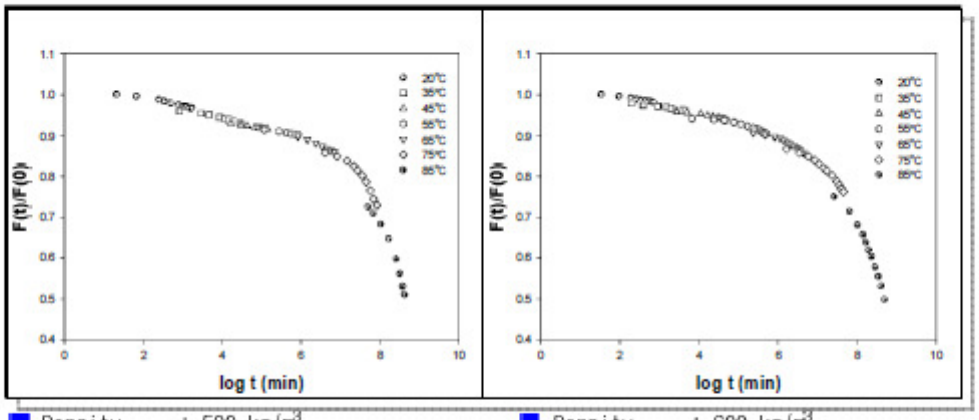
■ Density : 150 kg/m^3
■ Durability : Approx. 612Yrs(20℃)

■ Density : 220 kg/m^3
■ Durability : Approx. 630Yrs(20℃)



■ Density : 300 kg/m^3
■ Durability : Approx. 644Yrs(20℃)

■ Density : 400 kg/m^3
■ Durability : Approx. 652Yrs(20℃)



■ Density : 500 kg/m^3
■ Durability : Approx. 660Yrs(20℃)

■ Density : 600 kg/m^3
■ Durability : Approx. 675Yrs(20℃)

4. Comparison of Technical DATA

■ **Candidates : Spring Mounts, Rubber Mounts, PO MAT.**

■ **Material Properties**

NO.	ITEM	Material Type			REMARK
		SPRING	RUBBER	POLYURETHANE	
1	Photos				
2	Model	FSL2	NSNP	PO-MAT	
3	Type	COIL	PAD	MAT	
4	Loading Area	POINT	500x500mm	1000x1000mm	

■ **Noise and Vibration Properties**

NO.	ITEM	Material Type			REMARK
		SPRING	RUBBER	POLYURETHANE	
1	Viscosity	–	■	◎	
2	Static load(kgf/mm^2)	–	-	0,50	
3	Elastic strain(%)	–	about 20	up to 50	
4	Virtical load ratio	about 4.0	3.3	2.5	
5	Operating load capacity	◎	◆	◎	

■Remark:Excellent★, Very Good◎, Good◆, Normal▲, Not Good■, Not Applicable▼

■ **Physical Properties**

NO.	ITEM		Material Type			REMARK
			SPRING	RUBBER	POLYURETHANE	
1	Ultimate strength		–	200~260	up to 500	
2	Coefficient fo expansion		–	630%	260%	
3	Tensile Strength		◆	◆	◎	
4	Creep resistance		■	◆	◎	
5	Abrasion		★	◆	◆	
6	Cracking resistance		■	◎	◎	
7	Tearing Resistance	Drying	◎	◆	◎	
		Oil impregration	◎	■	◎	
8	Heat resistance		★	–	–	
9	Cold resistance		◆	◆	◎	
10	Permanent bend		◆	◆	◆	
11	Manufacturing capacity		▲	◆	◎	
12	Density(kg/m^3)		–	up to 450	up to 1500	
13	Using Temperature		◎		◆	

■Remark:Excellent★, Very Good◎, Good◆, Normal▲, Not Good■, Not Applicable▼

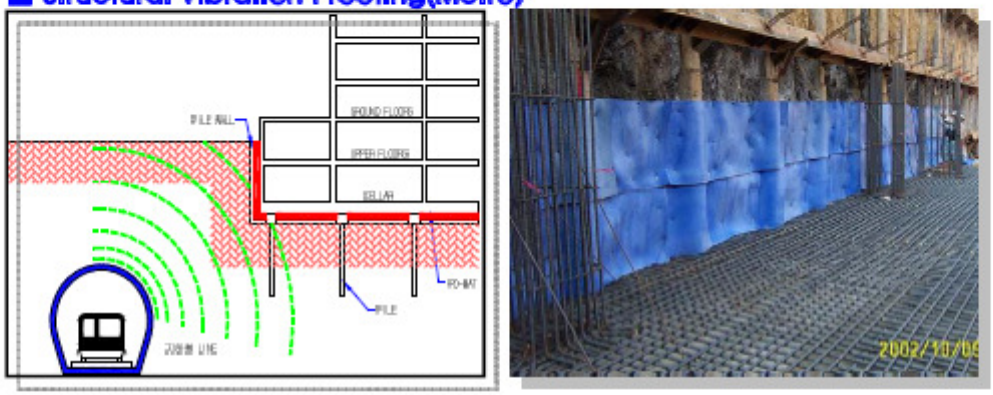
■ **Chmical Properties**

NO.	ITEM	Material Type			REMARK
		SPRING	RUBBER	POLYURETHANE	
1	Adhesion capacity	–	◎	★	
2	Oil resistance	◆	◆	◎	
3	O zone resistance	★	◆	◎	
4	Ageing resistance	◆	◆	★	
5	Biological Resistance	★	◎	★	
6	Water & Aqueous Solution	★(Corrosion)	◎	★	
7	Formic acid	◎(Corrosion)	■	▲	
8	Acetic acid	◎(Corrosion)	■	◎	
9	Phosphoric acid	◎(Corrosion)	▲	★	
10	Oils & Greases	◎(Corrosion)	◎	★	
11	Glycerol	◎(Corrosion)	◎	★	
12	Glycol	◎	◎	★	
13	Hexane	◎	◎	★	

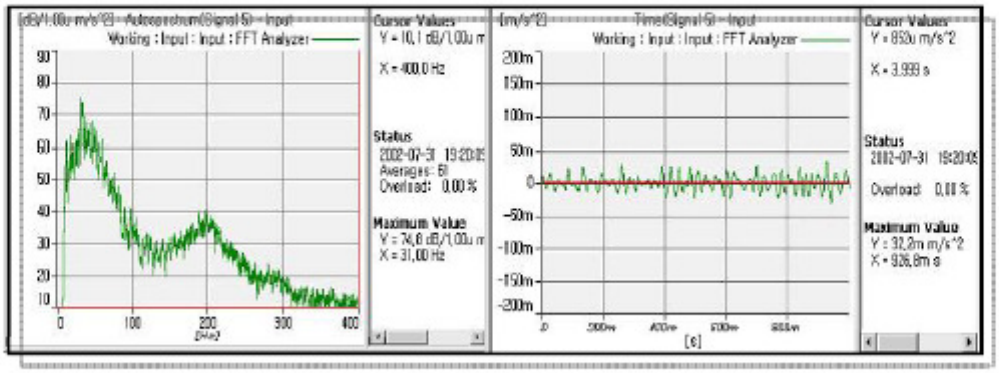
■Remark:Excellent★, Very Good◎, Good◆, Normal▲, Not Good■, Not Applicable▼

5. Application Data for PO-MAT

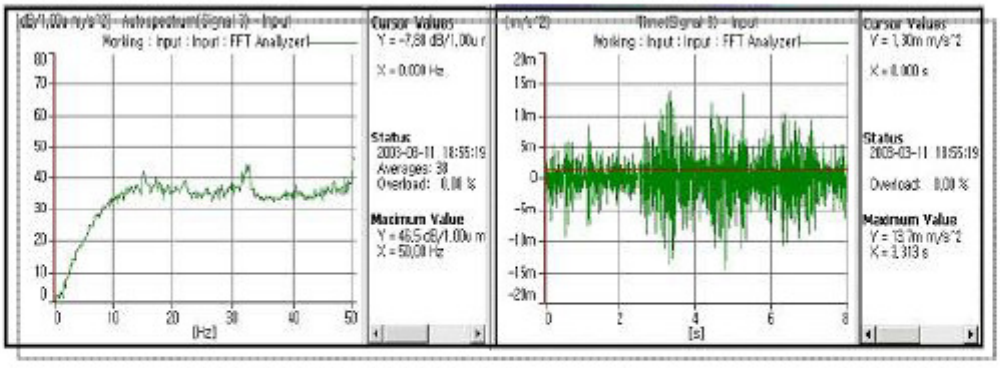
■ Structural Vibration Proofing(Metro)



■Outline of PO-MAT installation once subway train passes

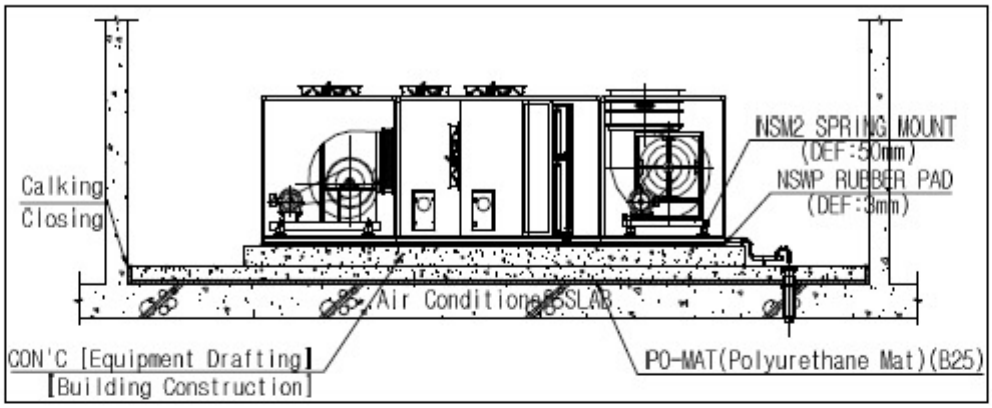


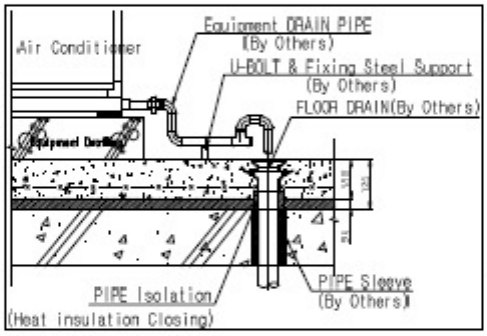
■Vibration analysis DATA once subway train passes before PO-MAT installation

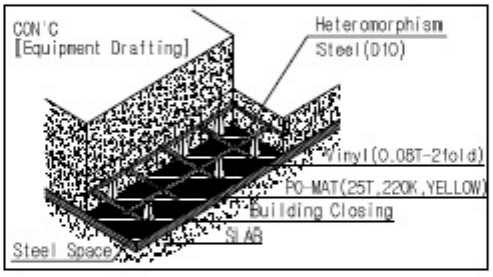


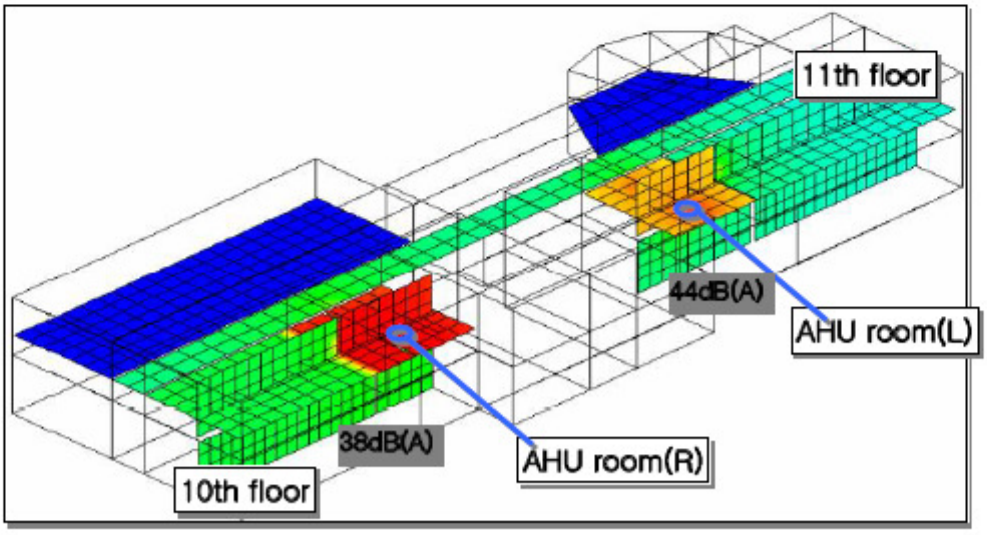
■Vibration analysis DATA once subway train passes after PO-MAT installation

■ Floating Floor on Machine Room(AHU Room)

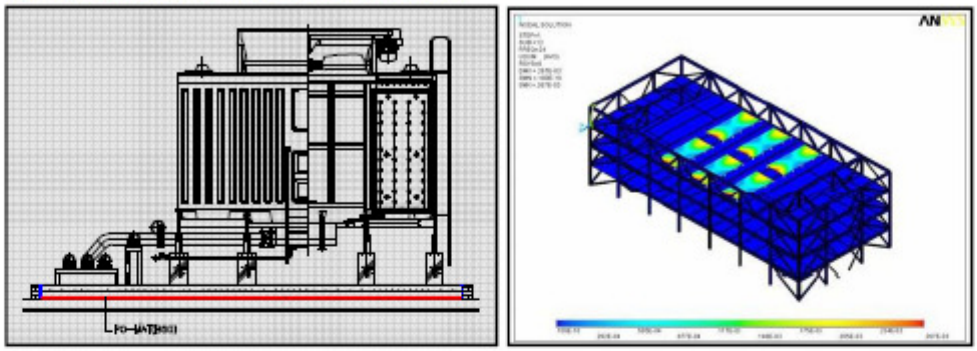




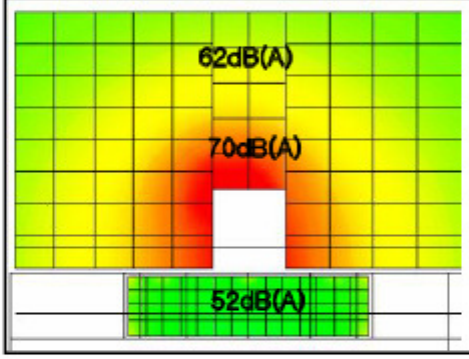




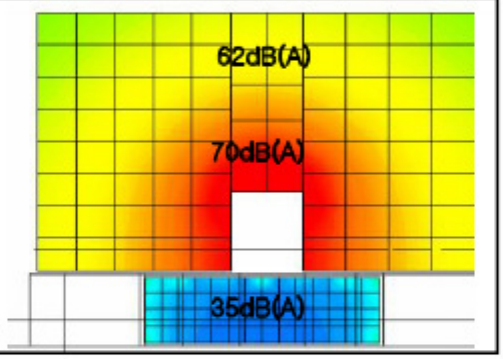
Floating floor for cooling tower



Cut way(before floating floor)

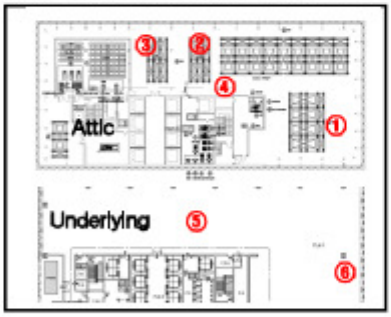


Cut way(after floating floor)

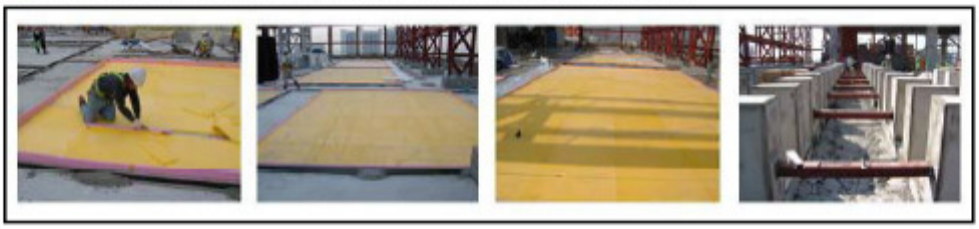


Noise measurement result for cooling tower on the roof(after floating floor)

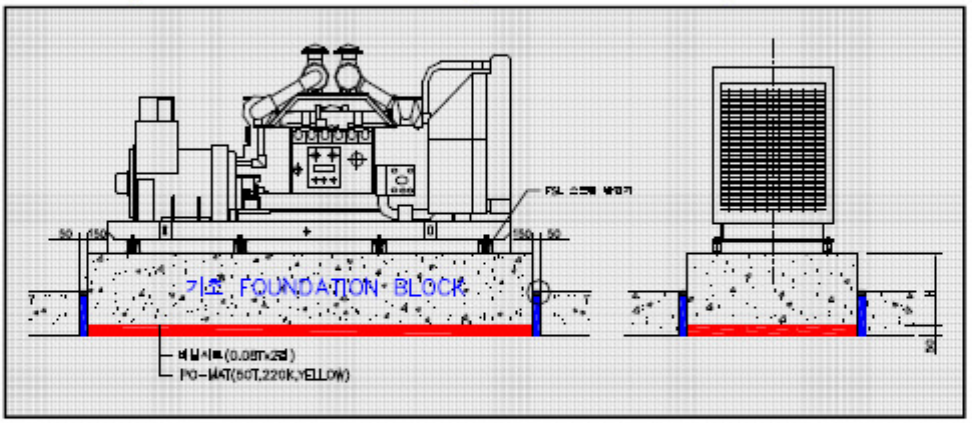
Location		Point	B.G.	CT	Δ	Remar
Attic	Suction	1	52.9	70.5	+17.6	–
		2		75.4	+22.5	–
		3		74.6	+21.7	
	Discharge	4		77.5	+24.6	
Underlying Layer		5	32.8	34.0	+1.2	–
		6	38.5	39.2	+0.7	–



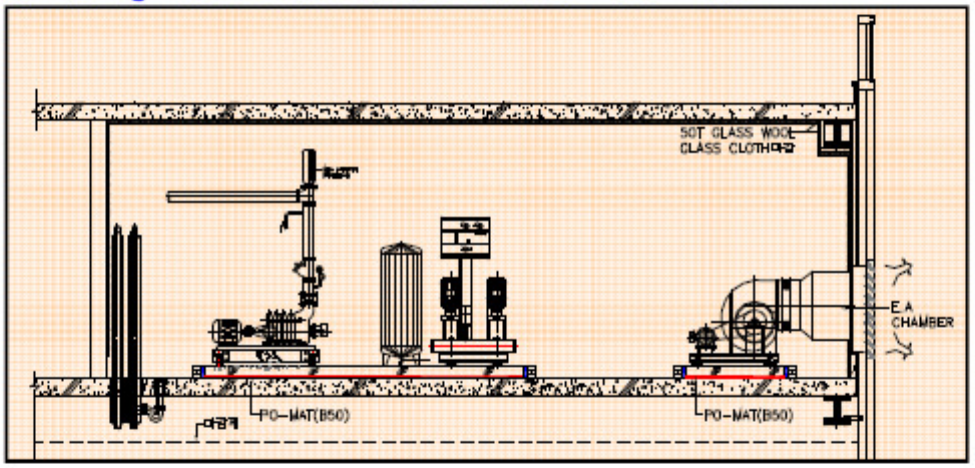
Floating Floor on Roof of Building for Cooling Tower



■ Floating Floor In Machine Room(Generation Room)



■ Floating Floor In Machine Room on Mid-Level Floor

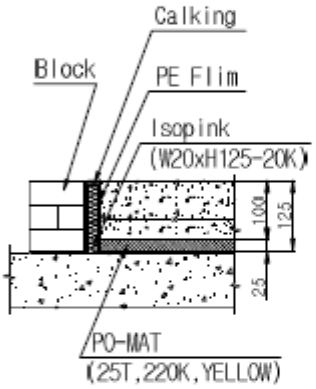
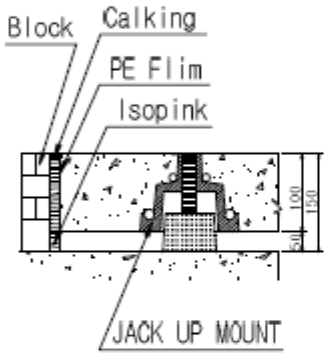


■ Other Special Structural Vibration Proofing

Amusement Park / Bumper(ship) / Metro Office / special application

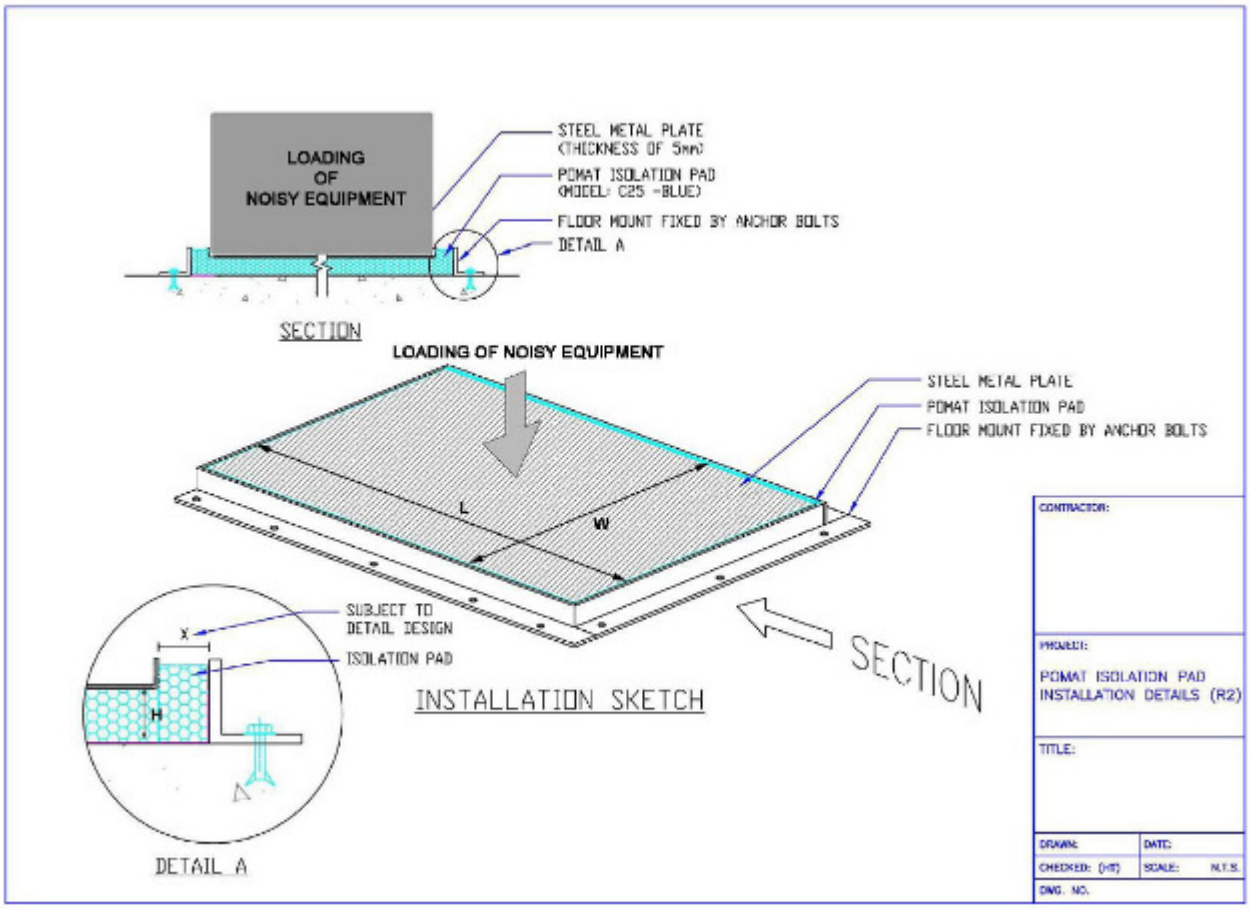
6. Comparison Data (PO-MAT vs Jack-Up System)

■ Comparison data for Floating Floor System

SYSTEM / ITEM	PO-MAT SYSTEM (Polyurethane Mat)	JACK-UP SYSTEM
Feature		
Consist	Single formular of Polyurethane Identified by color(density)	Engineering plastic + Neoprene mount
Cut way of installation		
Installation	1) Covering PO-MAT 2) Wire work after covering vynil sheet 3) Concrete work and dry	1) Vynil sheet cover, install jack-up mount 2) Wire work and concrete work 3) Dry and lifting floor
Noise absorbing layer	Absorbing noise by PO MAT	Absorbing noise by air and jack-up mo
Vibration absorbing efficiency	10~15dB	5~10dB
Tansmission Loss(TL)	52~54dB	52~54dB
Installation Characteristics	1) Durobility is permanent as the m is made of Polyurethane 2) Lifting work is not neccessary 3) Easy installation, short and stab construction period. 4) Distributed Load Application 5) Low Natural Frequency	1) Durobility is semi-permanent as the mount is made of Neoprene 2) Lifting work is necessary 3) Complicated installation, long perioc 4) Concentration Load Application 5) High Natural Frequency
Model	PO-MAT : A,B,C,D,E,F TYPE 6 models applicable	UM MOUNT: 300,650,800kg 3 models applicable

■ Comparison of installation(PO-MAT vs JACK-UP)

PO-MAT SYSTEM	JACK-UP SYSTEM
	
Spread PO-MAT on floor after cleaning	Sep-up Jack-up mount on vinyl sheet after cleaning
	
›ead 2 layers of vinyl sheet in the PO-MA	Reinforcing on the Jack-up mount
	
Wiremash & Concrete	Complete reinforcing
	
Drying concrete	Drying concrete & Lifting floor


LOADING
OF
NOISY EQUIPMENT
STEEL METAL PLATE
(THICKNESS OF 5mm)
POMAT ISOLATION PAD
(MODEL: C25 -BLUE)
FLOOR MOUNT FIXED BY ANCHOR BOLTS
DETAIL A
SECTION
LOADING OF NOISY EQUIPMENT
STEEL METAL PLATE
POMAT ISOLATION PAD
FLOOR MOUNT FIXED BY ANCHOR BOLTS
L
W
SECTION
SUBJECT TO
DETAIL DESIGN
ISOLATION PAD
X
H
INSTALLATION SKETCH
DETAIL A
CONTRACTOR:
PROJECT:
POMAT ISOLATION PAD
INSTALLATION DETAILS (R2)
TITLE:
DRAWN:
DATE:
CHECKED: (HT)
SCALE: N.T.S.
DWG. NO.

APPENDIX C - TYPICAL SET UP OF THE ACOUSTIC DECOUPLING MEASURES FOR THE GENERATOR