For information

Legislative Council Panel on Transport

Enhancement of Bridge Parapets and Roadside Barriers

PURPOSE

At their meeting on 21 April 2004, Members of the Public Works Sub-committee approved funding for 791TH: "Enhancement of Bridge Parapets and Roadside Barriers". The project comprises studies on enhancement of bridge parapets and roadside barriers, and strengthening of bridge parapets and roadside barriers at 39 priority locations. At the meeting, the Administration undertook to report to the Panel on Transport the methodology for and the findings of the studies that were targeted for completion by December 2005.

2. The studies have now been completed. This paper summarizes the methodology for and the findings of the studies. The opportunity is also taken to report on the progress of the works to strengthen bridge parapets and roadside barriers at the 39 priority locations identified.

BACKGROUND

3. Following the traffic accident at Tuen Mun Road on 10 July 2003, the Chief Executive appointed an Independent Expert Panel (IEP) to examine and make recommendations on safety measures to prevent similar incidents. The IEP released the Report on Enhancement of Highway Safety on 5 December 2003. As the Administration briefed the Panel on Transport on the Report on 19 December 2003, one of the recommendations of the IEP was to study and enhance the containment level for buses of bridge parapets and roadside barriers at the 39 priority locations identified and listed at **Annex A**.

PROGRESS

4. Since then, the Administration has –

(a) conducted studies on enhancement of bridge parapets and roadside barriers; and

(b) carried out works to strengthen bridge parapets and roadside barriers at the 39 priority locations along 16 road sections identified by the IEP.

5. The studies include -

(a) development and validation of new designs of bridge parapets and roadside barriers suitable for Hong Kong; and

(b) a comprehensive review of the containment levels of bridge parapets and roadside barriers.

Studies on Enhancement of Bridge Parapet and Roadside Barrier Designs

6. In the studies, several types of new and strengthened bridge parapet and roadside barrier designs, as shown at **Annexes B** and **C,** were developed for bus containment. Since there was limited knowledge worldwide specifically on the performance of bridge parapets and roadside barriers during the impact of a double-decked bus, we engaged a consultant to validate the capability of the new designs by conducting full-scale impact tests and computer simulations.

7. The consultant conducted four full-scale impact tests on the new designs at a testing ground around January 2005. The details of the tests are set out in the table below –

Test No.	Test Parapet/ Barrier	Test Vehicle	Total Vehicle Mass (kg)	Impact Velocity (km/h)	Angle of Impact (degree)
1	New 4-rail steel bridge parapet	Saloon car	*1,500*	*113*	*20*
2	New 4-rail steel bridge parapet	Double-decked bus	*20,000*	*50*	*20*
3	New 4-rail steel bridge parapet	Double-decked bus	*20,000*	*70*	*15*
4	Double thrie-beam roadside barrier	Double-decked bus	*22,000*	*50*	*20*

8. The test results show that the performance of the bridge parapets and roadside barriers is satisfactory. In all the tests,

(a) the test vehicles did not penetrate nor pass over the bridge parapets and roadside barriers;

(b) the test vehicles were redirected back to the carriageway area in a controlled manner; and

(c) no major components of the test vehicles, bridge parapets and roadside barriers were detached.

9. With the input from the full-scale impact tests, the consultant developed a computer model to simulate the effects of impacts caused by a saloon car and a double-decked bus. The consultant also analyzed the structure frame of a real bus to establish the necessary parameters for the computer model. The consultant then calibrated the computer model and simulated the interaction between the vehicle and the different designs of bridge parapets and roadside barriers at different impact angles and speeds, and with different vehicle loading conditions.

10. The consultant has concluded that both the new bridge parapet and roadside barrier designs at **Annexes B** and **C** are capable of containing a 22-tonne bus impacting at 50 km/h and 20 degrees. The study results also show that installing an additional row of thrie-beam barrier, which can provide cushioning effects, in front of the bridge parapets is an effective means to reduce damage to light vehicles impacting on the bridge parapet.

11. We also engaged Hong Kong Polytechnic University (PolyU) to carry out a parallel study on computer-simulated analyses on some of the new bridge parapets designed for bus containment. Using proprietary information on bus models provided by a bus manufacturer, PolyU's simulation generated results compatible with those of the consultancy study. This confirms the adequacy of the new designs.

Studies on Containment Level Standards for Bridge Parapets and Roadside Barriers

12. To review the standards of containment level and guidelines for

selection of bridge parapets and roadside barriers, and to explore the use of multiple containment bridge parapets in Hong Kong, Highways Department (HyD) collaborated with Hong Kong University of Science and Technology (HKUST) to conduct a comprehensive study.

13. HKUST reviewed similar standards currently used in the United Kingdom, Europe, the United States of America, Australia, Canada and Japan. The study findings are summarized below -

(a) using a performance-based approach, four containment levels (L1, L2, L3 and L4) have been developed for bridge parapets (see **Annex D**), and similar approach should be adopted for roadside barriers;

(b) detailed guidelines on the choice of containment level for bridge parapets and roadside barriers together with a scoring system for containment level L3 should be adopted;

(c) multiple containment levels could be adopted for containment levels L3 and L4 to minimize the damage of impacting light vehicles, but the implementation should be studied further; and

(d) L1 and L2 bridge parapets should have a minimum height of 1.0m, while L3 and L4 bridge parapets should have a minimum height of 1.5m.

14. Except for containment level L4, HKUST's proposed new containment levels are similar to the standards currently adopted by HyD. As for the proposed containment level L4, we are aware that such standards are still being developed in other countries. Since the existing high containment bridge parapets adopted for Hong Kong's highways are already meeting about 95% strength requirement of the L4 containment level proposed by HKUST, we do not intend to adopt HKUST's proposed L4 standard at this moment but will continue to monitor international development and consider further improvements in future.

15. For roadside barriers, HKUST's proposed approach of using containment levels as selection criteria is still being developed in different countries. We will monitor international advancements in this area and commission appropriate study to consider the best arrangement for adopting the

approach in Hong Kong.

16. As pointed out by HKUST, multiple containment bridge parapets and roadside barriers are still being developed. In the interim, we will continue to install thrie-beam barriers in front of strengthened bridge parapets where space is available as a means to minimize possible damage of light vehicles. We will also closely monitor worldwide developments on multiple containment bridge parapets and roadside barriers for use in Hong Kong as appropriate.

Bridge Parapet and Roadside Barrier Enhancement Works

17. HyD has implemented the new designs for bridge parapets and roadside barriers for bus containment at the 39 priority locations identified by the IEP. As at the end of December 2005, the enhancement works were 98% completed. The remaining works at Sha Tin Road over Lion Rock Tunnel Road (location 4-1 at **Annex A**) and Cheung Tsing Highway NT bound near Kam Chuk Kok (location 8-2 at **Annex A**) are in active progress. We expect that the remaining works will be completed by the end of January 2006.

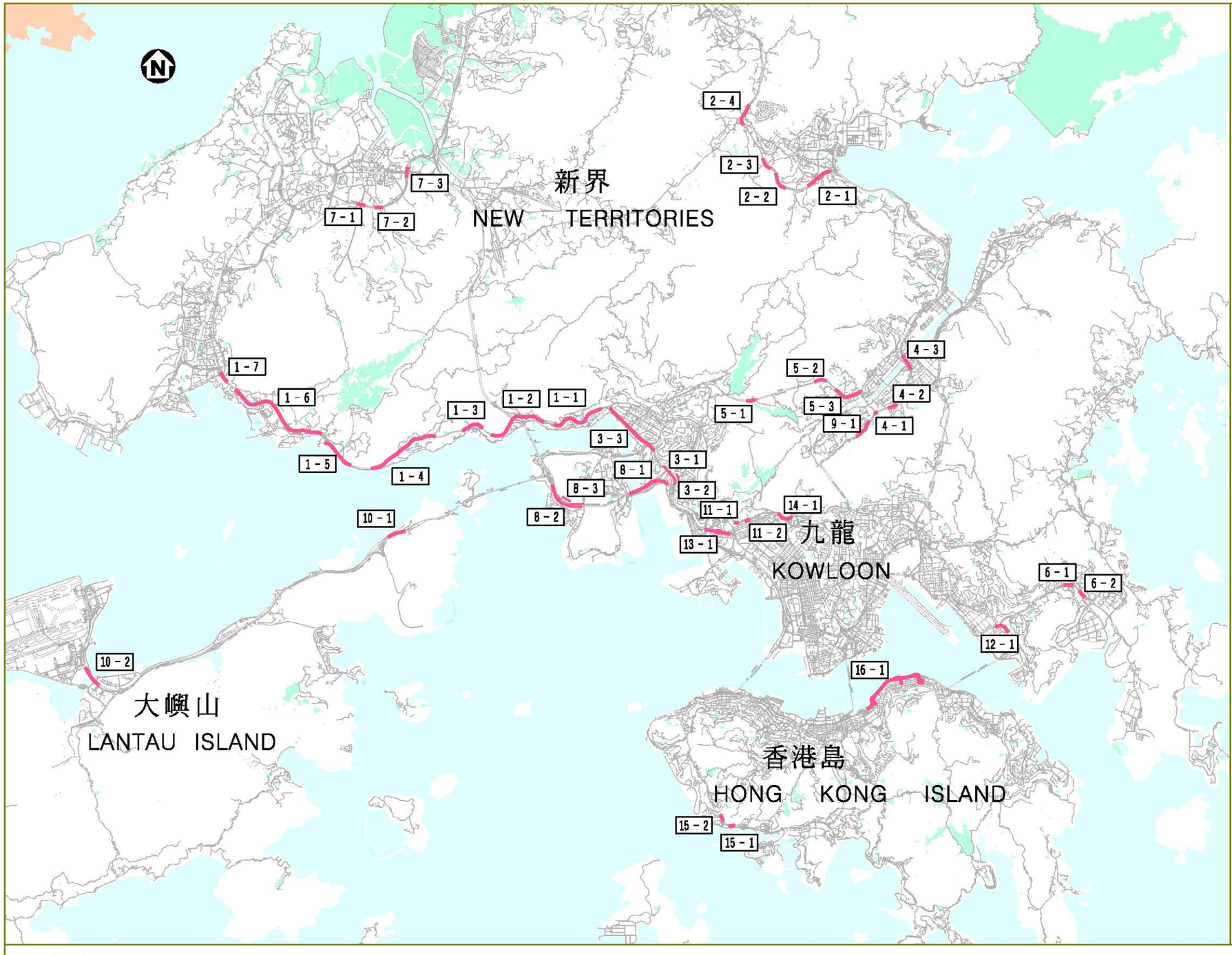
WAY FORWARD

18. The computer simulation model developed from the above studies provides a useful means for evaluation of the performance of bridge parapets and roadside barriers. HyD will adopt this computer simulation technique as a design tool in future development of bridge parapets and roadside barriers. We will adopt the new standards of bridge parapets and roadside barriers as mentioned above for existing and future highways. We will continue the installation of thrie-beam barriers in front of new or strengthened bridge parapets where space is available and will closely monitor worldwide developments on multiple containment bridge parapets and roadside barriers for use in Hong Kong as appropriate. We will continue the remaining enhancement works at the two priority locations for completion by the end of January 2006.

ADVICE SOUGHT

19. Members are invited to note the contents of this paper.

Environment, Transport and Works Bureau
January 2006



圖例 Legend :

1-1 辨識編號 Identification No.

地點 Location

加固橋面護欄及路旁圍欄一覽表

List of Bridge Parapets and Roadside Barriers to be Strengthened

地點 Location	辨識編號 Identification No.
1. 屯門公路 Tuen Mun Road	1 - 1 to 1 - 7
2. 吐露港公路 Tolo Highway	2 - 1 to 2 - 4
3. 荃灣路 Tsuen Wan Road	3 - 1 to 3 - 3
4. 沙田路 Sha Tin Road	4 - 1 to 4 - 3
5. 城門隧道公路 Shing Mun Tunnel Road	5 - 1 to 5 - 3
6. 將軍澳隧道公路 Tseung Kwan O Tunnel Road	6 - 1 to 6 - 2
7. 元朗公路 Yuen Long Highway	7 - 1 to 7 - 3
8. 長青公路 Cheung Tsing Highway	8 - 1 to 8 - 3
9. 獅子山隧道公路，隔田至豐盛苑段 Lion Rock Tunnel Road, section between Kak Tin and Fung Shing Court	9 - 1
10. 北大嶼山公路 North Lantau Highway	10 - 1 to 10 - 2
11. 呈祥道 Ching Cheung Road	11 - 1 to 11 - 2
12. 觀塘繞道，往鯉魚門道支路 Kwun Tong Bypass, slip road connecting Lei Yue Mun Road	12 - 1
13. 葵涌道，在美孚新邨前面一段 Kwai Chung Road, section fronting Mei Foo Sun Chuen	13 - 1
14. 龍翔道近大窩坪交匯處 Lung Cheung Road near Tai Wo Ping Interchange	14 - 1
15. 石排灣道 Shek Pai Wan Road	15 - 1 to 15 - 2
16. 東區走廊，介乎維園道及健康西街一段 Island Eastern Corridor, section between Victoria Park Road and Healthy Street West	16 - 1

圖則名稱 Plan title :

工務計劃項目第 791 TH 號
橋面護欄和路旁圍欄加固工程 - 擬建加固工程位置圖

PWP ITEM NO. 791 TH
ENHANCEMENT OF BRIDGE PARAPETS AND ROADSIDE BARRIERS - LOCATION PLAN OF PROPOSED STRENGTHENING WORKS

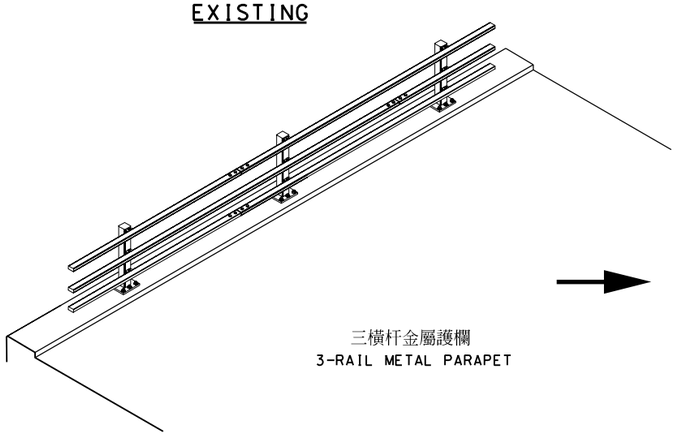
圖則編號 Plan no :

HSTOTH013-GL0011A

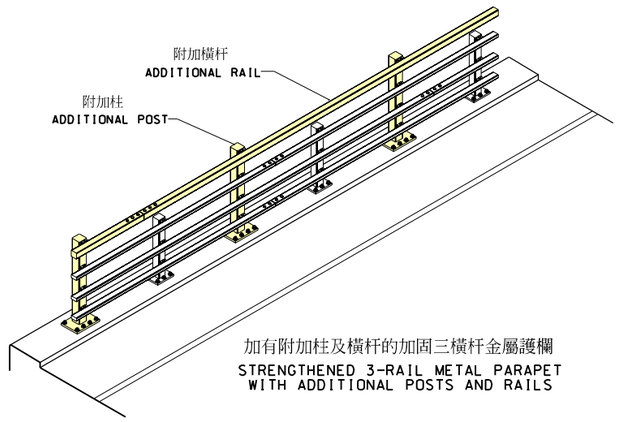
HIGHWAYS DEPARTMENT HONG KONG 路政署 香港

現有
EXISTING

擬建工程
PROPOSED

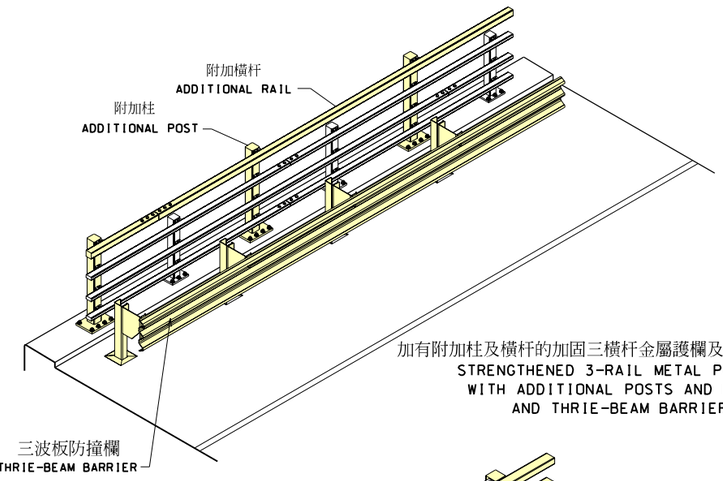


三橫杆金屬護欄
3-RAIL METAL PARAPET

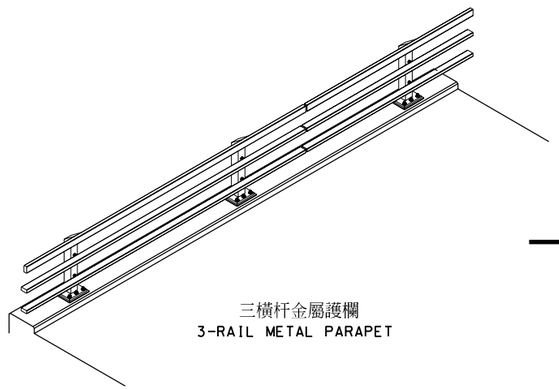


加有附加柱及橫杆的加固三橫杆金屬護欄
STRENGTHENED 3-RAIL METAL PARAPET
WITH ADDITIONAL POSTS AND RAILS

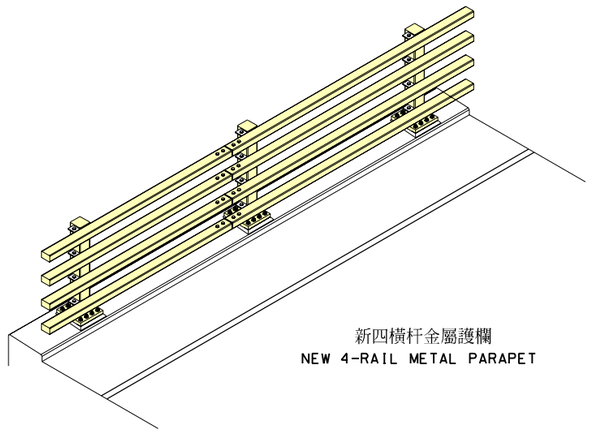
或
OR



加有附加柱及橫杆的加固三橫杆金屬護欄及三波板防撞欄
STRENGTHENED 3-RAIL METAL PARAPET
WITH ADDITIONAL POSTS AND RAILS
AND THRIE-BEAM BARRIER

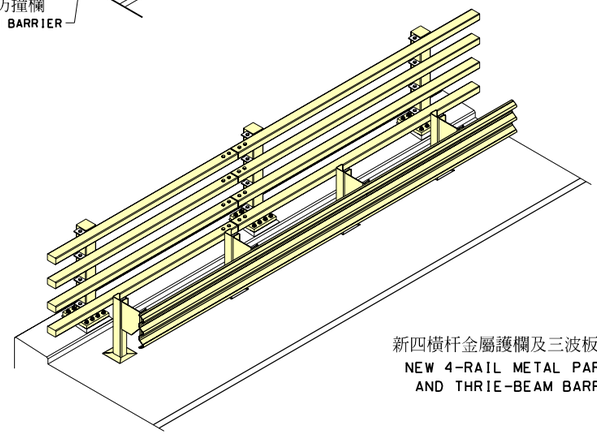


三橫杆金屬護欄
3-RAIL METAL PARAPET

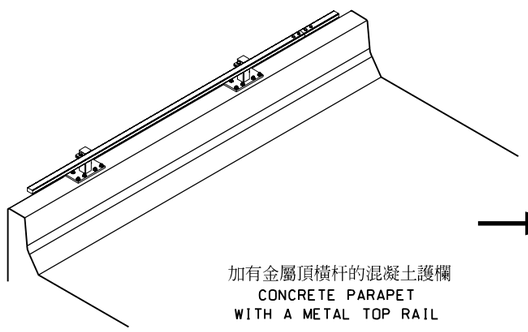


新四橫杆金屬護欄
NEW 4-RAIL METAL PARAPET

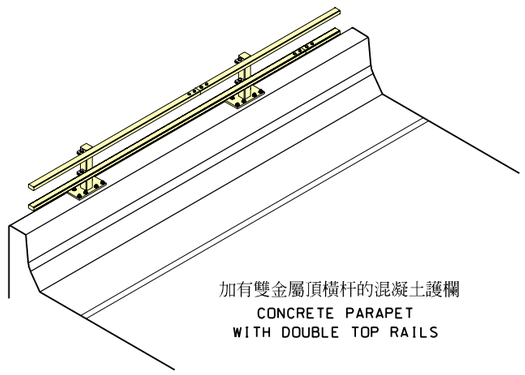
或
OR



新四橫杆金屬護欄及三波板防撞欄
NEW 4-RAIL METAL PARAPET
AND THRIE-BEAM BARRIER

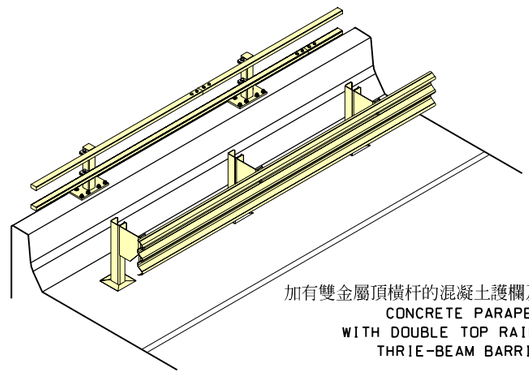


加有金屬頂橫杆的混凝土護欄
CONCRETE PARAPET
WITH A METAL TOP RAIL



加有雙金屬頂橫杆的混凝土護欄
CONCRETE PARAPET
WITH DOUBLE TOP RAILS

或
OR



加有雙金屬頂橫杆的混凝土護欄及三波板防撞欄
CONCRETE PARAPET
WITH DOUBLE TOP RAILS AND
THRIE-BEAM BARRIER

圖則名稱 Plan title：

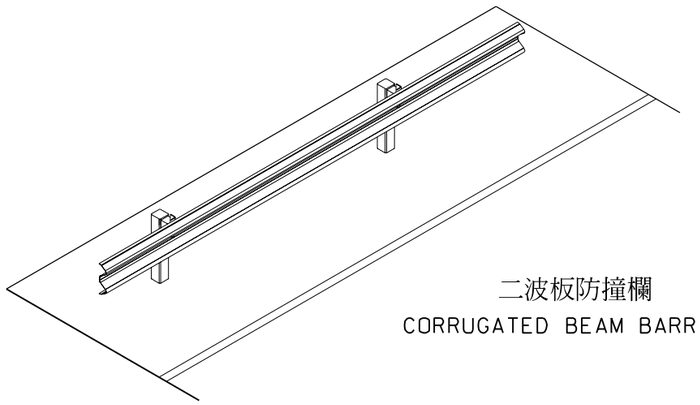
工務計劃項目第 791 TH 號
橋面護欄和路旁圍欄加固工程 – 擬建橋面護欄加固工程
PWP ITEM NO. 791 TH
ENHANCEMENT OF BRIDGE PARAPETS AND ROADSIDE BARRIERS – PROPOSED STRENGTHENING WORKS FOR BRIDGE PARAPETS

圖則編號 Plan no：

HSTOTH013-GA0011A

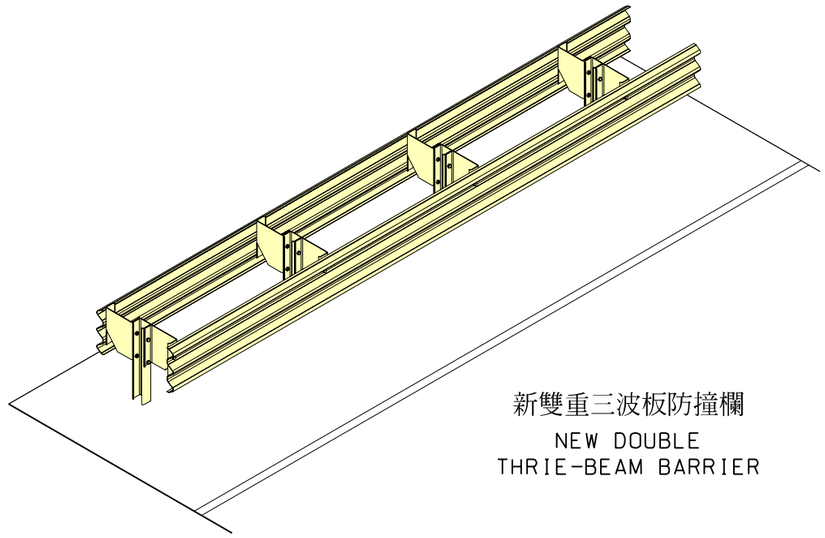
HIGHWAYS DEPARTMENT 路政署 香港
HONG KONG

現有
EXISTING

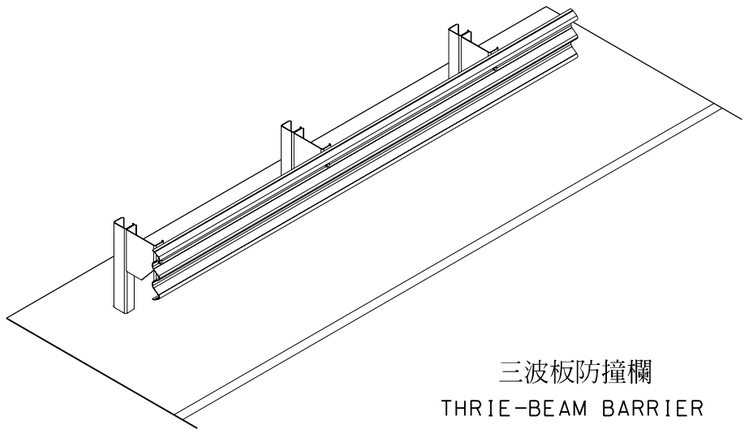


二波板防撞欄
CORRUGATED BEAM BARRIER

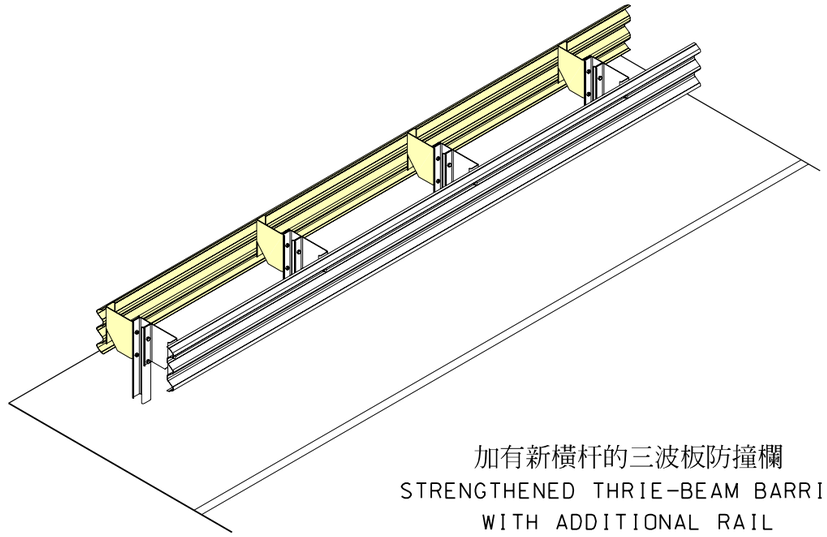
擬建工程
PROPOSED



新雙重三波板防撞欄
NEW DOUBLE
THRIE-BEAM BARRIER



三波板防撞欄
THRIE-BEAM BARRIER



加有新橫杆的三波板防撞欄
STRENGTHENED THRIE-BEAM BARRIER
WITH ADDITIONAL RAIL

圖則名稱 Plan title：

工務計劃項目第 791 TH 號
橋面護欄和路旁圍欄加固工程 – 擬建路旁圍欄加固工程
PWP ITEM NO. 791 TH
ENHANCEMENT OF BRIDGE PARAPETS AND ROADSIDE BARRIERS – PROPOSED STRENGTHENING WORKS FOR ROADSIDE BARRIERS

圖則編號 Plan no：

HSTOTH013-GA0012A

HIGHWAYS DEPARTMENT HONG KONG 路政署 香港

Annex D

Containment Level Standards for Bridge Parapets

HKUST's Recommended Standards for both Bridge Parapets and Roadside Barriers					**Existing Standards for Bridge Parapets**				
Level of Containment	*Vehicle Impact Characteristics*				**Level of Containment**	*Vehicle Impact Characteristics*			
	Type of Vehicle	*Vehicle Mass (tonne)*	*Impact Speed (km/h)*	*Impact Angle (degree)*		*Type of Vehicle*	*Vehicle Mass (tonne)*	*Impact Speed (km/h)*	*Impact Angle (degree)*
L1	Saloon Car	1.5	80	20	**Low**	Saloon Car	1.5	80	20
L2	Saloon Car	1.5	113	20	**Normal**	Saloon Car	1.5	113	20
L3	Double-decked bus	22	50	20	**Bus Containment**	Double-decked bus	20	50	20
L4	Heavy Goods Vehicle	36	60	20	**High**	Heavy Goods Vehicle	30	64	20

Notes :

1. There is high similarity between the recommended standards and the current standards for L1, L2 and L3.

2. Highways Department's existing standards for high containment bridge parapets (i.e. L4) are specified to provide a strength capable of containing a 30-tonne vehicle impacting at 64 km/h and 20 degrees. This is equivalent to about 95% of the strength requirement recommended by HKUST.

附件 D

橋面護欄的防撞等級標準

科大建議橋面護欄及路旁圍欄劃一採用的標準					橋面護欄的現行標準				
防撞等級	*車輛撞擊特性*				**防撞等級**	*車輛撞擊特性*			
	車輛類別	*車輛重量*	*撞擊速度 (每小時)*	*撞擊角度*		*車輛類別*	*車輛重量*	*撞擊速度 (每小時)*	*撞擊角度*
L1	小客車	1.5 公噸	80 公里	20°	**低**	小客車	1.5 公噸	80 公里	20°
L2	小客車	1.5 公噸	113 公里	20°	**正常**	小客車	1.5 公噸	113 公里	20°
L3	雙層巴士	22 公噸	50 公里	20°	**巴士可承受的撞擊**	雙層巴士	20 公噸	50 公里	20°
L4	重型貨車	36 公噸	60 公里	20°	**高**	重型貨車	30 公噸	64 公里	20°

註：

1. 建議的 L1、L2 及 L3 防撞等級標準與現行標準非常相近。
2. 根據路政署的現行規定，高防撞等級(即 L4)的橋面護欄須能擋住以時速 64 公里從 20^{o} 撞來的 30 公噸重車輛。這個標準相等於科大建議的防撞等級標準的 95%左右。