



HIGHWAYS DEPARTMENT

**GUIDELINES FOR
DESIGN OF END-DETAILS OF
THREE-BEAM BARRIER FENCE**

Research & Development Division

**RD/GN/040
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**(Formerly
HQ/GN/10
March 2007)**

Highways Department
HQ/GN/10
Guidelines for Design of End-details of Thrie-beam Barrier Fence

Aim of Guidelines

1. Since early 2000's, thrie-beam barrier fence has been used in the Hong Kong road network to enhance road safety. The ending arrangements of thrie-beam barrier fence, as now adopted in overseas countries, are not entirely suitable for the Hong Kong situation. As such, different ending arrangements have been adopted by local road designers to suit individual site conditions. Photos showing some of the existing thrie-beam end details are attached in Appendix A.
2. In November 2004, a Task Force on Thrie-beam was set up within the Highways Department under the chairmanship of the Regional Highway Engineer/New Territories to review and recommend the ending arrangements of thrie-beam barrier fence to suit local conditions and to achieve consistence in design. The Membership and Terms of Reference of the Task Force are attached in Appendix B.
3. The recommendations given in these guidelines have been derived with reference to the ending arrangements of thrie-beam barrier fence currently adopted in overseas countries and, most importantly, based on the professional experience and knowledge of the members of the Task Force.
4. It should be noted that at present even in overseas countries, there are no physical or computer simulated test-proven end details of the thrie-beam barrier fence. The thrie-beam barrier fence is generally connected to a line of w-beam barrier fence, which terminates with an end anchorage system. Impact tests have been conducted on these types of w-beam terminal systems overseas and the results are satisfactory.

Overseas Experience and Hong Kong Conditions

5. The thrie-beam barrier fence used in Hong Kong is mainly based on standards of two overseas countries: Australia and the United States. In both the Australian and US standards, crashworthy end terminals should be provided to end of barrier fences and the barrier fences should be flared away from the carriageway as far as practicable. Currently, crashworthy end terminals are gating systems which allow an impacting vehicle to pass through. In the Australian standard [1], "gating

terminal” adjoining a line of W-beam barrier fence is the standard for the ending arrangement of thrie-beam barrier fence, which is designed to break away and allow a vehicle to pass through upon impact. An area of 22.5m (long) by 6.0m (width) immediately behind the gating terminal should be free from fixed-object hazards. In the US standard [2], a large runout area behind the end terminal is required, similar to the Australian standard.

6. The above requirements for the provisions of gating terminal system may not be practical for most roadside conditions in Hong Kong. To achieve traffic safety under local constraints, the following alternative approaches can be considered taking into account the risk and consequences of head-on collision:
 - (a) Extend the thrie-beam barrier fence to flare the end away from the carriageway and anchor it onto the ground beyond the clear-zone¹ using concrete anchor block.
 - (b) Extend the thrie-beam barrier fence and anchor the end onto an adjacent uphill slope, retaining wall, concrete profile barrier or bridge parapets.
 - (c) Provide a crash cushion for the leading end of thrie-beam barrier fence.
7. The roads in Hong Kong can be classified into 3 broad categories when considering the type of end treatment to be adopted for thrie-beam barrier fences:
 - (i) Expressways
 - (ii) Roads with posted speed limit of 70km/h or above but not expressway
 - (iii) Roads with posted speed limit below 70km/h

Recommendations for End Treatments to Thrie-beam Barrier Fences on Expressways

8. Expressways are major carriageways designed to high alignment standards with widely spaced grade separated junctions and with no frontage access. The traveling speed of the vehicles and traffic volume are high where the consequence of traffic accident would be severe. Treatment to thrie-beam barrier ends should therefore always be to the highest possible standard.

¹ Clear-zone - the horizontal width of space available for the safe use of an errant vehicle. The clear-zone consists of the hard shoulder, the verge together with any adjacent slope not steeper than 1:4, and is measured from the nearside edge of the left-hand traffic lane. In both the Australian and US standards, installation of crashworthy terminal is required unless the barrier end is outside the clear-zone (where most of the vehicles leaving a roadway out of control could recover) or is located in an area where it will unlikely be struck by an errant vehicle.

Extend the thrie-beam barrier fence to flare the end away from the carriageway and anchor it onto the ground beyond the clear-zone using concrete anchor block

9. Leading ends of thrie-beam barrier fences shall be flared away from the carriageway at the rate suggested in Table 3.9.3.2 of the Transport Planning and Design Manual Vol. 2 Chapter 3 and then anchored outside the clear-zone using concrete anchor block. Typical arrangement for the leading end is given on Drawing No. TB-01. Suggested clear-zone distances, measured from the edge of through traveled way, are given in Chapter 3 of the AASHTO Roadside Design Guide 2002 for different design speeds, traffic flows and topographic conditions, which are partly reproduced in Appendix C. A typical section illustrating the available clear-zone distance of a road is also included in the Appendix. The required clear-zone distances range from 5m to 14m in general. In any case, the lateral flare distance of the terminal from the main alignment of the barriers shall not be less than 1000mm. For trailing ends, the typical arrangement is given on Drawing No. TB-02. The required clear-zone and flare distances for the leading ends are also applicable to trailing ends if end-on impact by opposite traffic is anticipated. Otherwise the clear-zone requirement is not applicable for trailing ends.

10. The details of the concrete anchor blocks for leading and trailing ends are given on Drawing Nos. TB-03 and TB-04 respectively. The concrete anchor block eliminates the transition W-beam in current practice and reduces the chance of leaping for errant vehicles by increasing the height of the nosing (a 500mm high vertical nosing face is provided to match the general bumper level). The anchor block is provided with a rounded head and chamfered side faces to reduce the severity of damage to vehicles upon impact. The connector piece for the thrie-beam barrier fence shall be fixed onto the concrete anchor block by five numbers of bolts which provide strong anchorage force to the fence during impact. The connector piece has been used in Australia and the US for connecting thrie-beam to concrete bridge parapet. There is a small concrete cover for the connector piece in the design of the anchor block for the leading end to prohibit protrusion of the connector piece and the thrie-beam towards the direction of traffic in case of vehicle impact close to the rear end of the anchor block. The small concrete cover shall be constructed monolithically with the anchor block. The end post spacing shall be 1000mm while the standard post spacing shall be 2000mm. This ending arrangement should be adopted even though it will require the relocation of fire hydrants or underground utilities to give way for the construction of the concrete anchor block.

11. For double thrie-beam barrier fence, details of the concrete anchor block for leading and trailing ends are given on Drawing Nos. TB-05 and TB-06 respectively, in which the double thrie-beams are connected to each concrete anchor block by two connector pieces. A small concrete cover to the connector piece is required for the leading end at the side facing the through traveled way.
12. A crash cushion (paragraph 20 below) shall be installed to enclose the leading end of a thrie-beam barrier fence located at the diverging point for the main road and the slip road.

Extend the thrie-beam barrier fence and anchor the end onto adjacent uphill slope, retaining wall, concrete profile barrier or bridge parapets

13. Depending on the actual situation, consideration could be given to anchor the end of thrie-beam barrier onto an adjacent uphill slope, retaining wall, barrier or parapet. If flaring of thrie-beam barrier to tie-in with these adjacent features is required, it shall be at the rate recommended in Table 3.9.3.2 of the Transport Planning and Design Manual Vol. 2 Chapter 3.
14. Anchorage of thrie-beam barriers onto adjacent uphill slopes shall follow the typical arrangement on Drawing No. TB-15B. Typical arrangement for anchorage of thrie-beam onto adjacent retaining wall is detailed on Drawing No. TB-17 and TB-18. The above arrangement will not be appropriate if it is necessary to maintain through access on the verge between the slope/retaining wall and the barrier fence.
15. The connection of a thrie-beam or double thrie-beam barrier fence with a concrete profile barrier at the leading end on an at-grade road shall comply with Drawing No. TB-07. The connection details at the trailing end of the thrie-beam barrier fence shall comply with Drawing No. TB-08. Both connections shall make use of a concrete connector and a connector piece. A small concrete cover to the connector piece is required for the leading end at the side facing the through traveled way.
16. The connection of a thrie-beam or double thrie-beam barrier fence with a concrete vehicle parapet on a bridge shall comply with Drawing No. TB-09A whenever space is available for the construction of a concrete anchor block. If space is not available, the concrete vehicle parapet shall connect to the concrete profile barrier first and then to thrie-beam barriers in accordance with Drawing No. TB-10A.

17. The connection of a thrie-beam barrier fence with a steel parapet shall comply with Drawing Nos. TB-11C and TB-20. A single thrie-beam barrier fence shall not be connected directly onto a L3 steel vehicle parapet. If such connection is necessary, the thrie-beam barrier fence should be connected to a L1 or L2 steel vehicle parapet first which should then be connected with the L3 steel vehicle parapet according to Drawing No. HSTOTH014-BA0071 issued by Structures Division.
18. Where a thrie-beam barrier fence is to be installed as a cushion for light vehicles in front of a bridge parapet, it should be aligned with upstream and downstream barriers to avoid reduction of horizontal clearance to traffic and the need for special endings. Subject to the agreement of the Chief Highway Engineer of the Bridges and Structures Division, Transport Department and all others concerned, special thrie-beam ending arrangement may be adopted on a bridge as shown on the attached Drawing Nos. TB-12, TB-13 and TB-23.
19. Where a cushioning thrie-beam barrier fence is to be installed across a bridge movement joint, a thrie-beam movement joint shall be provided as shown on the attached Drawing No. TB-14.

Provide a crash cushion for the leading end of thrie-beam barrier fence

20. If it is not practical to terminate a thrie-beam barrier fence according to the aforementioned methods, consideration may be given to installation of a crash cushion for the leading end of the barrier fence. The crash cushion shall comply with the requirements of section 3.9.4 of Transport Planning and Design Manual Volume 2 published by TD. In general, flaring of barrier fence is not required if a crash cushion is installed unless otherwise specified by the manufacturer.

Recommendations for End Treatments to Barrier fences on Roads other than Expressways but with Posted Speed Limit of 70km/h or above

21. Non-expressways are seldom fitted with hard shoulders and their roadside verges are rarely as wide as those of expressways. There may also be pedestrian accesses at roadsides which may need to be retained. Whilst all these make full compliance of barriers on these roads with the guidelines for expressways difficult, the guidelines described in paragraphs 9 to 19 above should be followed wherever practicable subject to availability of resources. Where site situation allows, discrete sections of barriers may be linked up to form a continuous barrier and

extended to end at a lower speed road section, so as to reduce the necessity of sophisticated end treatment.

22. In the event that none of the treatment arrangements described in paragraphs 9 to 19 is feasible, consideration could be given to installation of a crash cushion for the leading end of the barrier fence subject to consultation among Highways Department, Transport Department and all others concerned and availability of resources.

Recommendations for End Treatments to Barrier Fences on Roads with Posted Speed Limit below 70km/h

23. The recommendation in the guidelines above are not applicable to roads with posted speed limit below 70km/h as the speed of vehicles on these roads is in general lower because of the lower posted speed limit and the presence of more at-grade junctions, crossings, frontage accesses and/or stoppage areas. End of thrie-beam barrier fence may follow the current practice of transiting to a line of w-beam barrier fence and then end with a standard anchor block (HyD Standard Drawing No. H2121). Where possible and appropriate, flaring of barrier fence should be considered.

Application to W-beam Barrier Fences

24. Arrangement of end details for W-beam barrier fences on roads of posted speed limit of 70km/h or above may also refer to the principles of these guidelines where appropriate.

Observations on Existing Arrangements on Expressways that have Room for Improvement

25. It is observed that some common existing arrangements for roadside facilities on expressways may have room for improvement and deserve special attention.
 - The leading end of a concrete profile barrier is sometimes purposely preceded with a short section of W-beam barrier fence starting with an anchor block on the ground according to HyD Standard Drawing No. H2117. This arrangement is not desirable as an errant vehicle may jump up upon impact with the slanting anchor under high speed. Furthermore, due to the higher flexibility of the W-beam barrier in comparison with the concrete profile barrier, head on collision of an errant vehicle to the blunt end of the concrete profile barrier may occur following deflection of the W-beam barrier during a crash. The

arrangement may be avoided by extending the beam barrier to connect with the barrier in the preceding road section (to eliminate the anchor block) and transit end of the beam to a thrie-beam barrier according to HyD Standard Drawing No. H2196 and then anchor the thrie-beam onto the concrete profile barrier according to Drawing No. TB-08.

- Butt joint between a thrie-beam barrier fence and the blunt leading end of a concrete profile barrier is sometimes observed. Due to the higher flexibility of the thrie-beam barrier in comparison with the concrete profile barrier, head on collision of an errant vehicle to the blunt end of the concrete profile barrier may occur following deflection of the thrie-beam barrier during a crash. Such arrangements should be replaced by the standard details in Drawing No. TB-08.
- Roadside obstacles (e.g. raised manholes) are sometimes observed to be purposely preceded with a short section of W-beam barrier fence starting with an anchor block on the ground according to HyD Standard Drawing No. H2117 and with a butt ending to the obstacle. This arrangement is not desirable due to reasons explained in the previous paragraphs. To improve the situation, the barrier fences before and after the obstacle should be linked up to form a continuous barrier. Introduction of an anchor block for the sake of 'protection' against the obstacle should be avoided.
- Short gaps in barrier fences are sometimes observed for facilitating emergency operation of fire hydrants. This situation may induce hazard and should be avoided by raising the hydrant and closing the gap between the barrier fences.
- Butt joint between a thrie-beam barrier fence and the blunt leading end of a steel bridge parapet is sometimes observed. Due to the difference in flexibility of the thrie-beam barrier in comparison with the steel parapet, head on collision of an errant vehicle to the blunt end of the steel parapet may occur following deflection of the thrie-beam barrier during a crash. Such arrangements should be replaced by the standard details in Drawing Nos. TB-11C.

Implementation

26. Existing ending arrangements of thrie-beam barrier fence, if not in compliance with the principles depicted in these guidelines, shall be modified according to these guidelines whenever resources and site conditions permit.

27. References

- [1] Joint Standards Australia/Standards New Zealand Committee (1999) Road safety barrier systems, AS/NZS 3845:1999, Australia/New Zealand
- [2] American Association of State Highway and Transportation Officials (2002) Roadside Design Guide 2002, Washington D.C.
- [3] The U.S.A. National Cooperative Highway Research Program Report 350 – Recommended Procedures for the Safety Performance Evaluation of Highway Features

28. Appendices

- Appendix A – Membership and Terms of Reference of Task Force on Thrie-beams
- Appendix B – Photos showing some of the existing thrie-beam end details
- Appendix C – Suggested clear-zone distances for different design speeds, traffic flows and topographic conditions, and available clear-zone distance of a typical road
- Appendix D - General Arrangement and Reinforcement Details Drawings

**Membership and Terms of Reference
of Task Force on Thrie-beams**

Title

Task Force on Thrie-beams

Membership

Chairman	:	RHE/NT
Members	:	SE/RRD (currently SE/HSR(E)), NT Region SE/HSR (currently SE/HSR(W)), NT Region SE/P2, Bridges & Structures Division SE/H, Bridges & Structures Division SE2/LMC (currently SE2/NM), Major Works Project Mgt Offices SDE/HES, Urban Region SE/R&D1, Research & Development Division E/2, Research & Development Division
Secretary	:	SE/MNT (currently SME/STR(NT)), NT Region
Ad-hoc Member on need basis	:	Representative from the Road Safety and Standard Division, Transport Department Representative form Hong Kong Police Force

Terms of Reference

1. To review the design, primarily the end-details of thrie-beam barriers in local conditions;
2. To recommend modifications to the design of thrie-beam barriers, if necessary, and standard end-details of thrie-beam barriers for different site conditions;
3. To oversee and monitor the implementation of modifications works to existing thrie-beam barriers;
4. To recommend, as appropriate, consultancy studies, research work and testing on long term design of thrie-beam barriers; and
5. Act as HyD's co-ordinator in the provision of professional statements in request of the design of thrie-beam barriers.

Frequency of Meetings

As needed



Photo 1: Existing Leading Terminal of Thrie-beam Barrier Fence at Roadside



Photo 2: Existing Trailing Terminal of Thrie-beam Barrier Fence at Roadside.



Photo 3: Existing Transition between Thrie-beam and W-beam



Photo 4: Existing connection of a Concrete Vehicle Parapet to Thrie-beam Barriers

Suggested clear-zone distances for different design speeds, traffic flows and topographic conditions

(Extracted from Table 3.1 in Chapter 3 of the Roadside Design Guide 2002 published by AASHTO)

Speed (km/h)	Average Daily Traffic	CLEAR-ZONE DISTANCES FROM EDGE OF THROUGH TRAVELED WAY (m)**	
		Cross Fall of Verge or Downhill Slope equals 1V:6H or flatter	Cross Fall of Verge or Downhill Slope equals 1V:5H to 1V:4H
70–80	1500-6000	5.0 – 5.5	6.0 – 8.0
	OVER 6000	6.0 – 6.5	7.5 – 8.5
100	1500-6000	8.0 – 9.0	10.0 – 12.0*
	OVER 6000	9.0 – 10.0*	11.0 – 13.5*
110	1500-6000	8.5 – 10.0*	10.5 – 13.0*
	OVER 6000	9.0 – 10.5*	11.5 – 14.0*

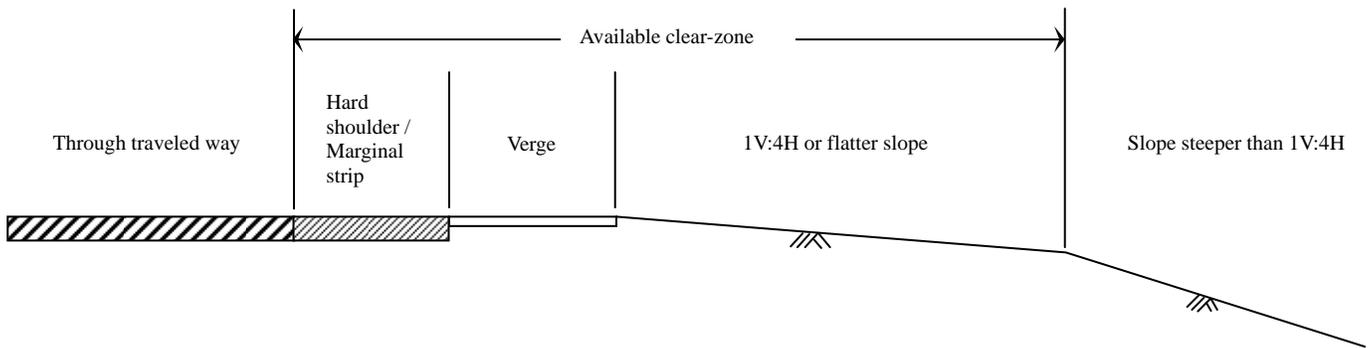
* Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear-zone distances greater than the clear-zone shown in this table. Clear-zones may be limited to 9m for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.

** The distance should be measured horizontally which includes the hard shoulder, the verge and adjacent downhill slope not steeper than 1V:4H.

Remarks: Distances of clear-zone measured on uphill slope indicated in Table 3.1 are not reproduced since under HK situation the barrier will rather be anchored onto the uphill slope instead of demanding a large clear-zone.

Figures in Table 3.1 for average daily traffic less than 1500 are not reproduced since they are not applicable for the high speed roads in HK.

Available clear-zone distance of a typical carriageway



Typical section illustrating the available clear-zone distance of a carriageway

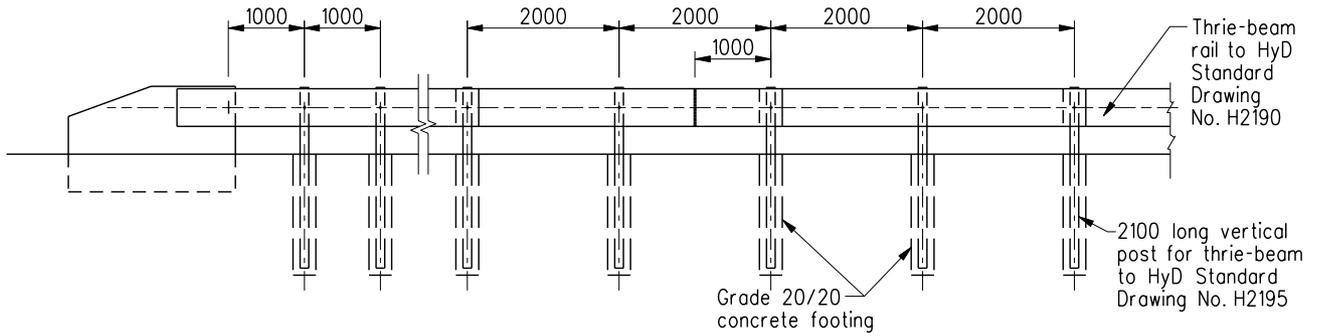
Appendix D

Guidelines for Design of End-details of Thrie-beam Barrier Fence

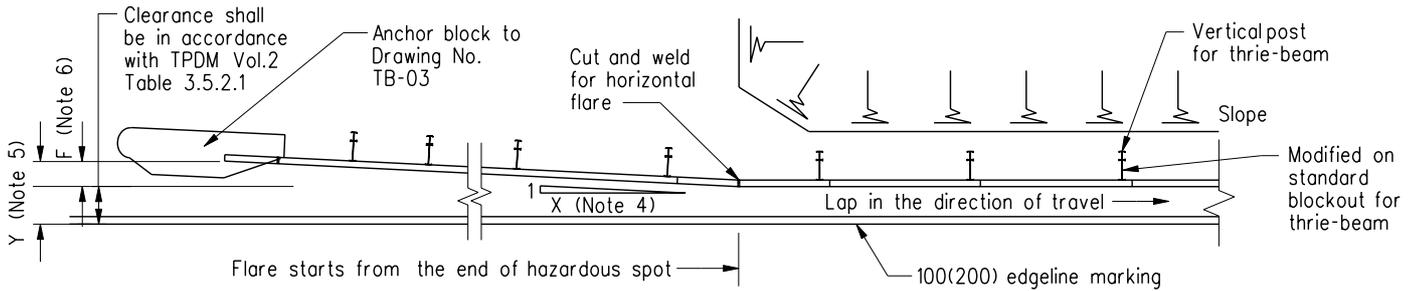
General Arrangement	
HyD Drawing No.	Drawing Title
TB-01B	Leading Terminal of Thrie-beam Barrier at Roadside
TB-02B	Trailing Terminal of Thrie-beam Barrier at Roadside
TB-03	Connection Details of Thrie-beam Barrier to Concrete Anchor Block at Leading Terminal
TB-04	Connection Details of Thrie-beam Barrier to Concrete Anchor Block at Trailing Terminal
TB-05	Connection Details of Double Thrie-beam Barrier to Concrete Anchor Block at Leading Terminal
TB-06	Connection Details of Double Thrie-beam Barrier to Concrete Anchor Block at Trailing Terminal
TB-07	Interface Details of Thrie-beam Barrier to Concrete Profile Barrier (Sheet 1 of 2)
TB-08	Interface Details of Thrie-beam Barrier to Concrete Profile Barrier (Sheet 2 of 2)
TB-09A	Direct Connection of a Concrete Vehicle Parapet to Thrie-beam Barrier
TB-10A	Connection of a Concrete Vehicle Parapet to Concrete Profile Barrier
TB-11C	Connection Details of Thrie-beam Barrier to L1 / L2 Steel Vehicle Parapet - Leading End (Trailing End as well if there is site constraints)
TB-12A	Thrie-beam for use as cushion - End Type I (for Leading End only)
TB-13B	Thrie-beam for use as cushion - End Type II
TB-14	Details of Thrie-beam at Bridge Movement Joint

General Arrangement	
HyD Drawing No.	Drawing Title
TB-15B	End of Thrie-beam Barrier to be blended with Uphill Slope
TB-17	Terminal of Thrie-beam Barrier anchored to Retaining Wall
TB-18	Connection Details of Thrie-beam Barrier to Retaining Wall
TB-20	Connection Details of Thrie-beam Barrier to L1 / L2 Steel Vehicle Parapet - Trailing End
TB-23	Thrie-beam for use as cushion - End Types III & IV

Reinforcement Details	
HyD Drawing No.	Drawing Title
TB-03(R)	Reinforcement Details of Thrie-beam – Concrete Anchor Block at Leading Terminal
TB-04(R)	Reinforcement Details of Thrie-beam – Concrete Anchor Block at Trailing Terminal
TB-05(R)	Reinforcement Details of Double Thrie-beam – Concrete Anchor Block at Leading Terminal
TB-06(R)	Reinforcement Details of Double Thrie-beam Concrete Anchor Block at Trailing Terminal
TB-07(R1)	Reinforcement Details of Concrete Connector (Sheet 1 of 4)
TB-07(R2)	Reinforcement Details of Concrete Connector (Sheet 2 of 4)
TB-08(R1)	Reinforcement Details of Concrete Connector (Sheet 3 of 4)
TB-08(R2)	Reinforcement Details of Concrete Connector (Sheet 4 of 4)

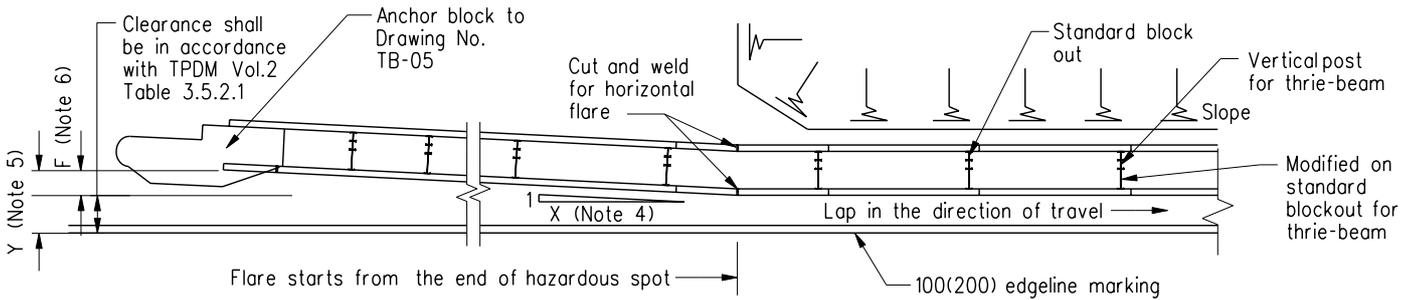


ELEVATION WITH BEAM END TO ANCHOR BLOCK



PLAN WITH BEAM END TO ANCHOR BLOCK

(Modified on standard thrie-beam barrier)



PLAN WITH BEAM END TO ANCHOR BLOCK

(Thrie-beam barrier with additional rail at the back)

Notes:

1. Details apply to roads of speed limit 70kph or above.
2. All dimensions are in millimeters.
3. Where the concrete footing is located in block paved footpath, the footing should be made of colour concrete with colour to tie with that of the paving blocks.
4. Flare rate X refers to Table 3.9.3.2 of TPDM Vol2 Chapter 3.
5. For expressways, the barrier end shall be located outside the clear-zone. Please refer to Appendix C of the 'Guidelines for Design of End-details of Thrie-beam Barrier Fence' for the clear-zone distance (Y). End of barrier shall also flare away from the main alignment of the barrier by 1000mm or above (flare distance - F).
6. For roads other than expressways, the desirable flare distance - F should be 1000mm or above. The flare distance shall never be less than 500mm.

B	Plan for thrie-beam barrier with additional rail at the back added		Nov 06
A	Addition of clear-zone distance requirement for expressways. Alternative special end details deleted.		Sep 06
REF.	REVISION	SIGNATURE	DATE

title

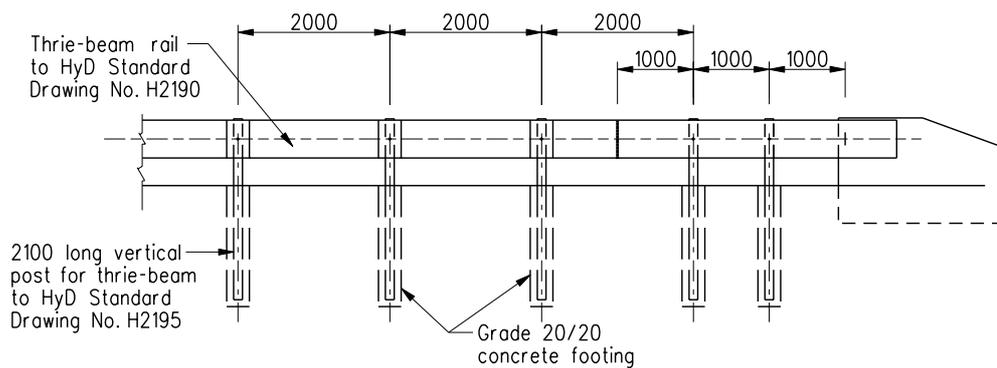
**LEADING TERMINAL OF
THRIE-BEAM BARRIER
AT ROADSIDE**

scale

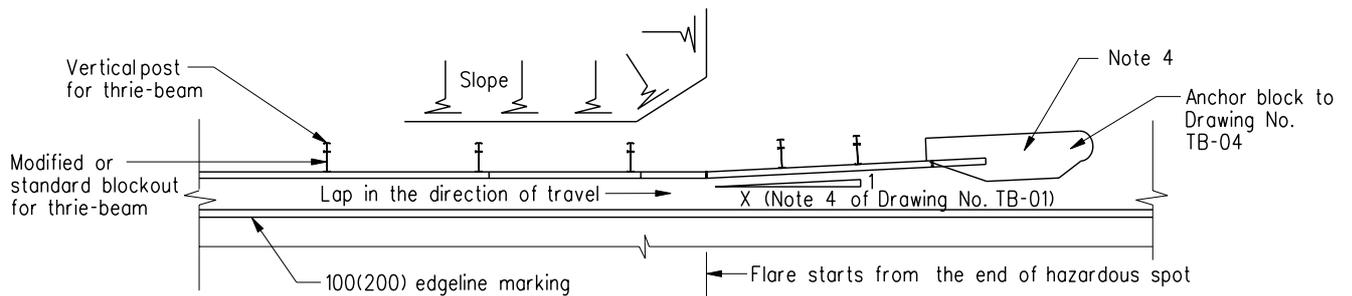
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drawing no.

TB-01B

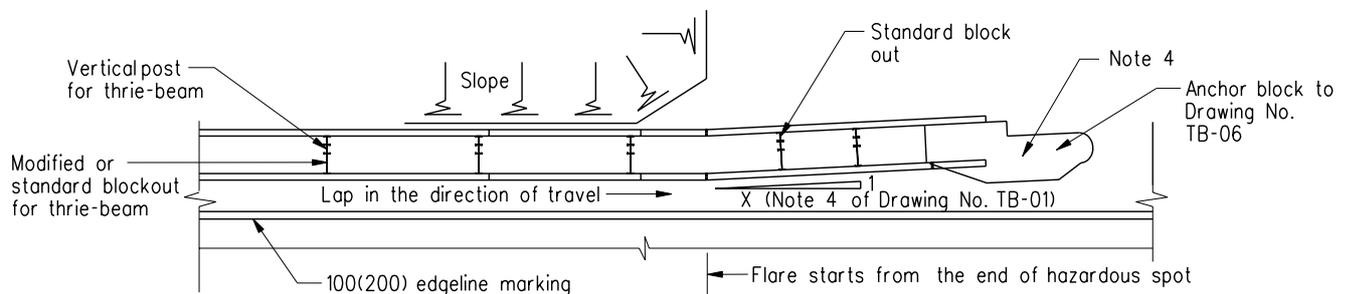


ELEVATION WITH BEAM END TO ANCHOR BLOCK



PLAN WITH BEAM END TO ANCHOR BLOCK

(Modified on standard thrie-beam barrier)



PLAN WITH BEAM END TO ANCHOR BLOCK

(Thrie-beam barrier with additional rail at the back)

Notes:

1. Details apply to roads of speed limit 70kph or above.
2. All dimensions are in millimetres.
3. Where the concrete footing is located in block paved footpath, the footing should be made of colour concrete with colour to tie with that of the paving blocks.
4. Please refer to the clear-zone and flare distances in TB-01 if end on impact by opposite traffic is anticipated (e.g. undivided road, contra-flow, etc).

B	Plan for thrie-beam barrier with additional rail at the back added		Nov 06
A	Addition of clear-zone distance requirement for expressways. Alternative special end details deleted.		Sep 06
REF.	REVISION	SIGNATURE	DATE

title

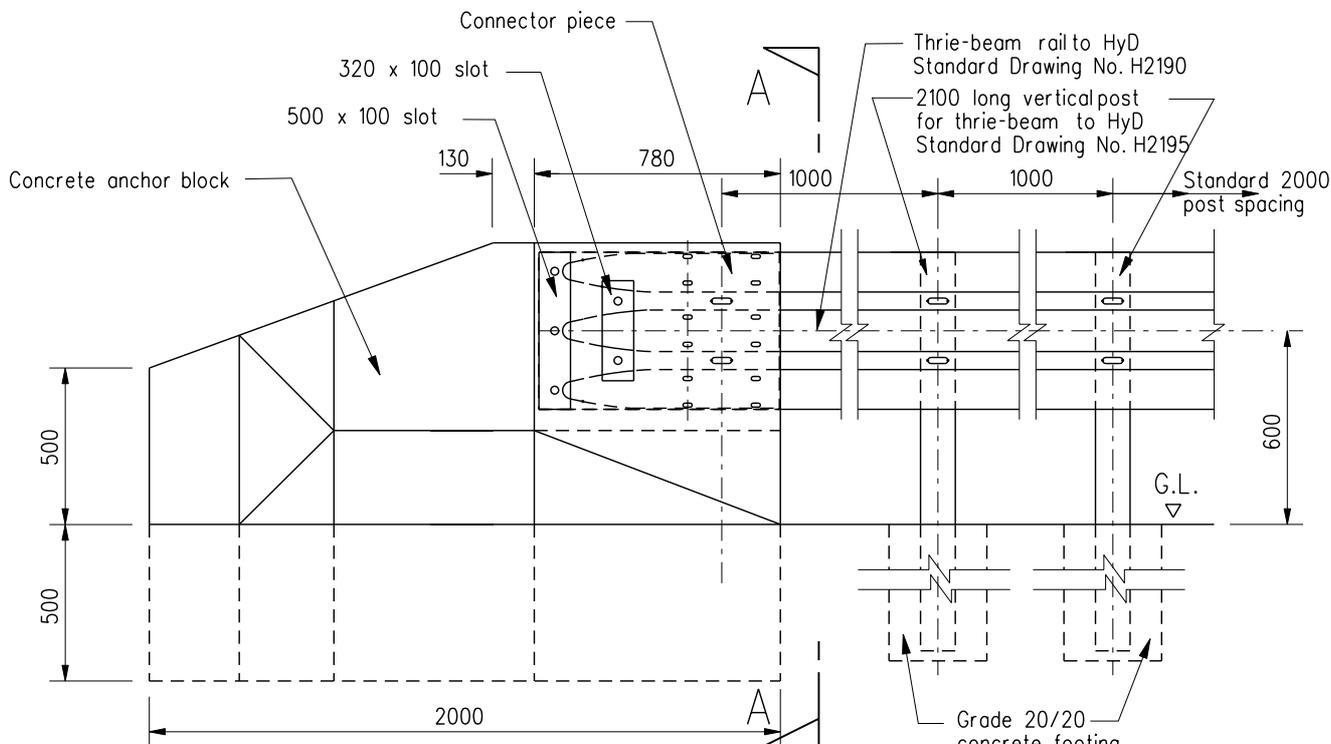
**TRAILING TERMINAL OF
THRIE-BEAM BARRIER
AT ROADSIDE**

scale

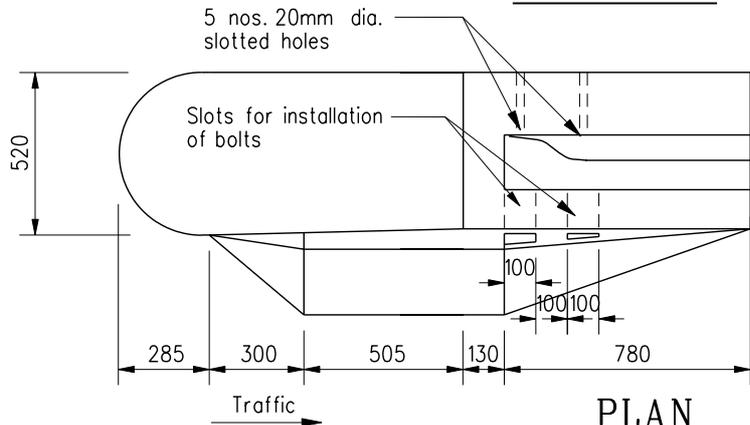
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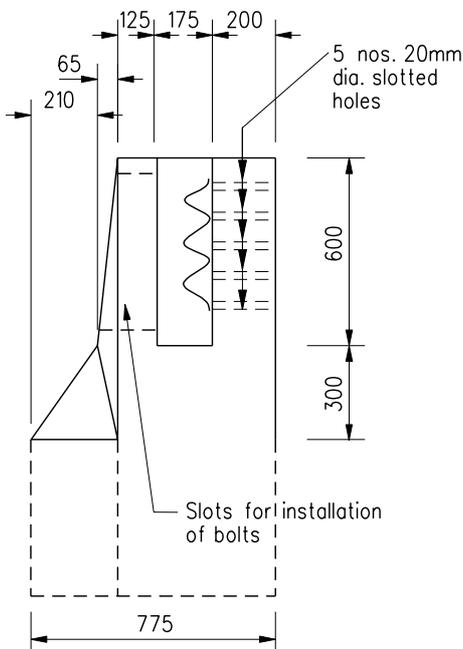
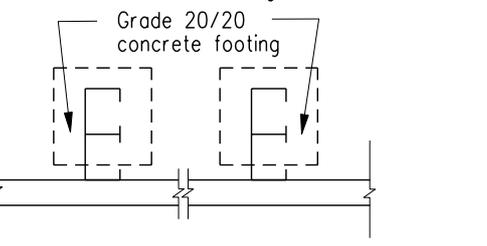
TB-02B



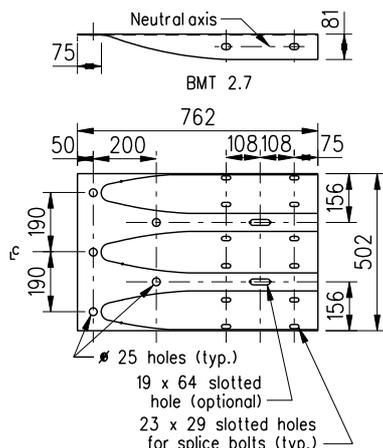
ELEVATION



PLAN



SECTION A-A



CONNECTOR PIECE FOR THRIE-BEAM

- Notes:
1. All dimensions are in millimetres.
 2. See HyD Standard Drawing No. H2197 for details of splice bolts connecting beam rail and connector piece.
 3. Connector piece shall be fixed to concrete anchor block by five numbers M16 hot dip galvanized bolt.
 4. Connector piece shall be formed from steel grade HA350 in accordance with AS/NZS 1594 or others approved by the Engineer.
 5. Except where tolerances are shown in the drawings, all dimensions are subject to manufacturer's tolerances and the approval of the Engineer. Dimensional tolerances for all components, if not shown or implied, shall be consistent with the proper functioning of the component, involving its appearance and accepted manufactured practices.

title

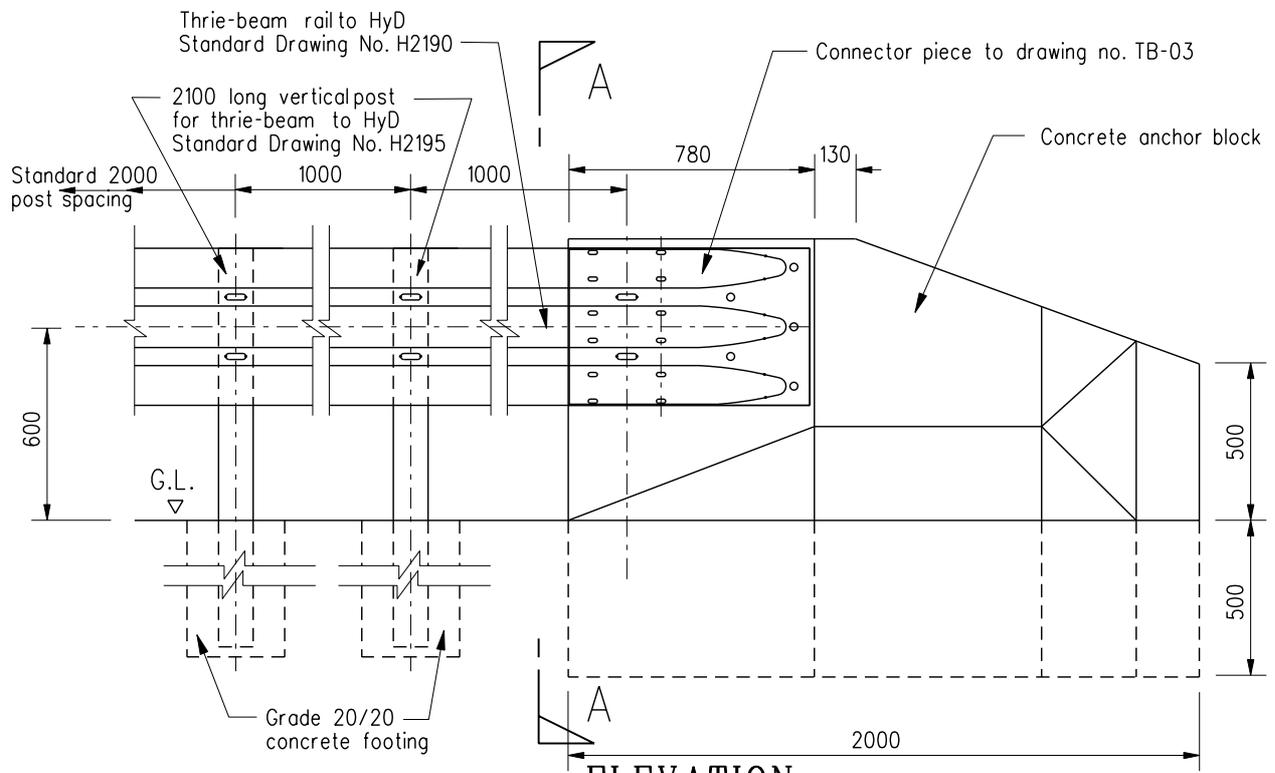
CONNECTION DETAILS OF THRIE-BEAM BARRIER TO CONCRETE ANCHOR BLOCK AT LEADING TERMINAL

scale

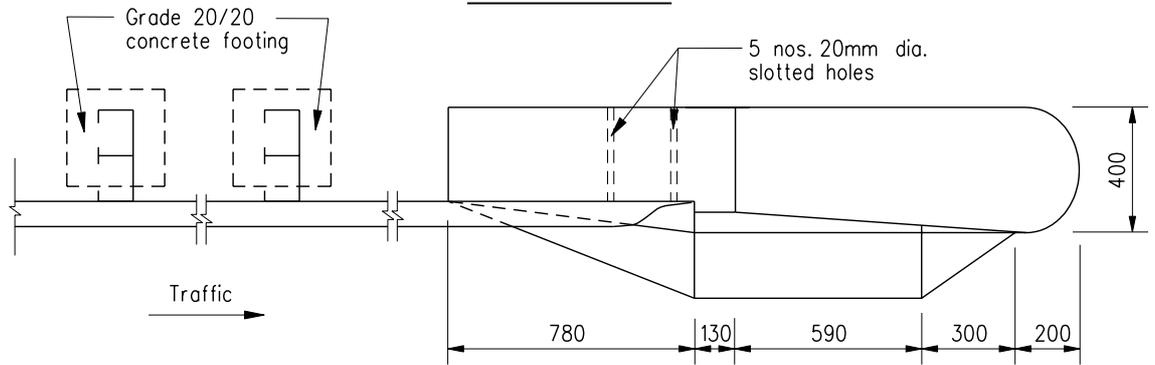
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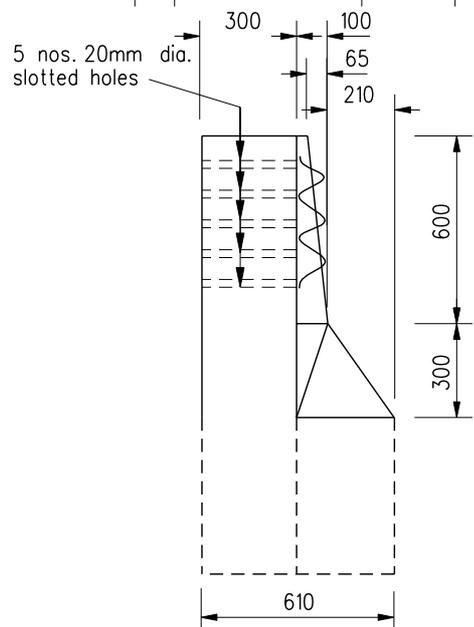
TB-03



ELEVATION



PLAN



SECTION A-A

- Notes:
1. All dimensions are in millimetres.
 2. See notes on drawing no. TB-03.

title

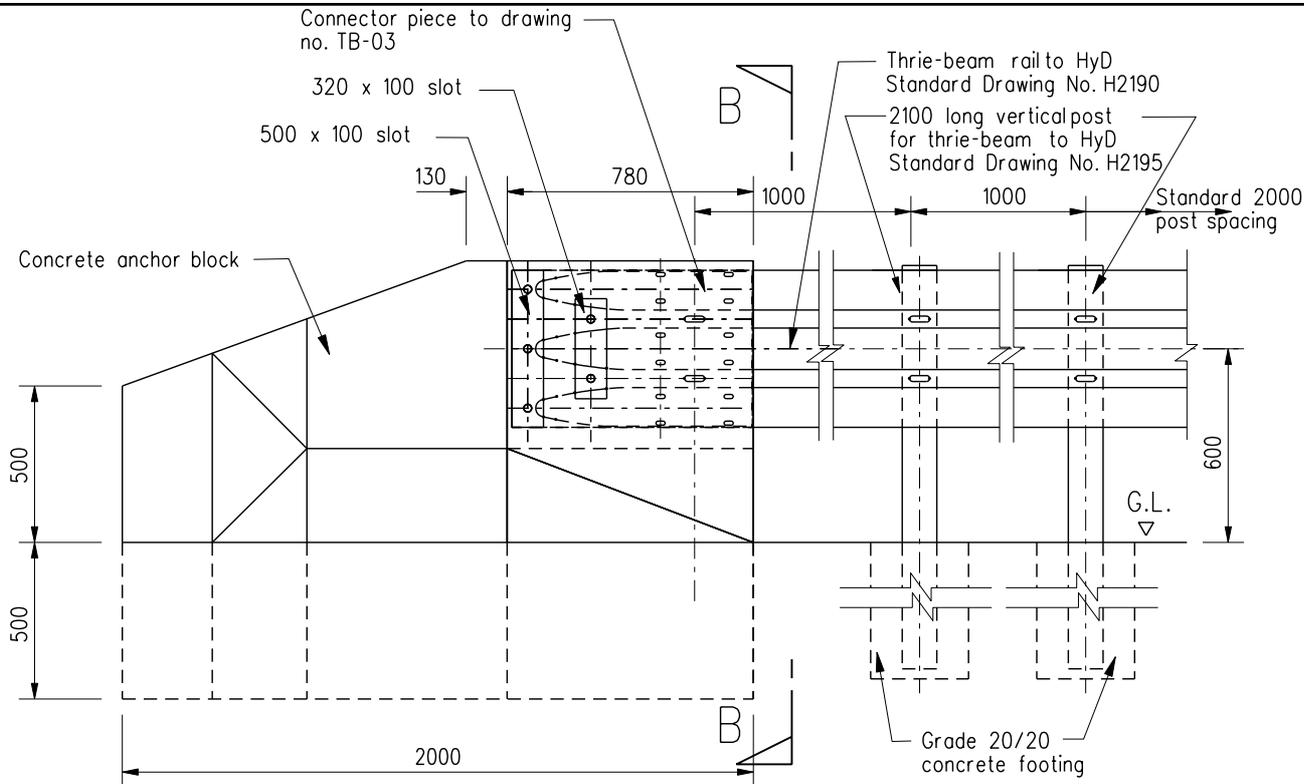
CONNECTION DETAILS OF THRIE-BEAM BARRIER TO CONCRETE ANCHOR BLOCK AT TRAILING TERMINAL

scale

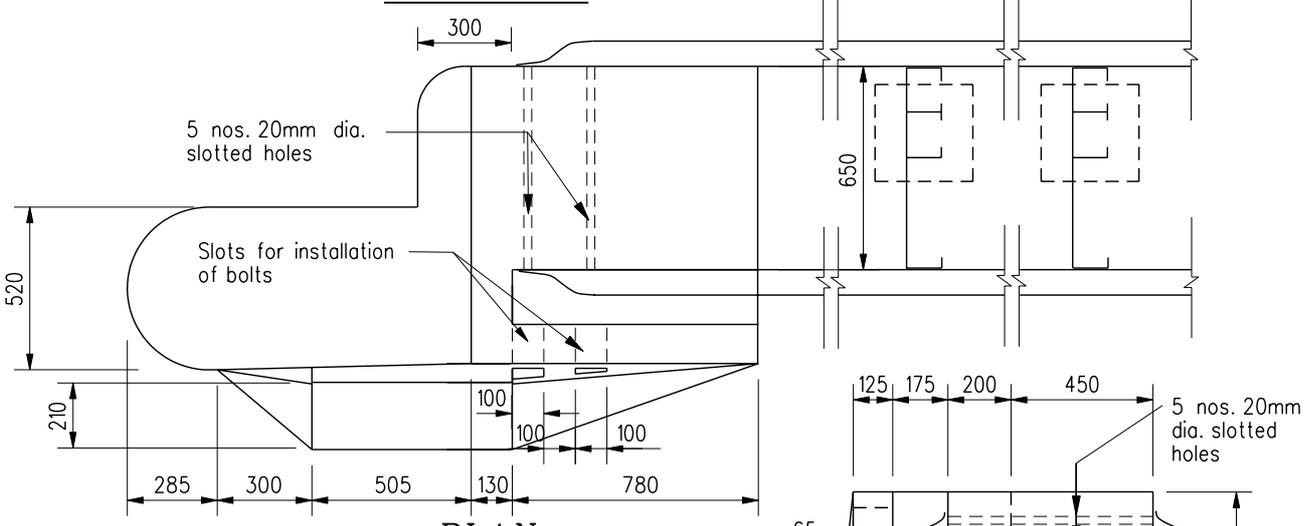
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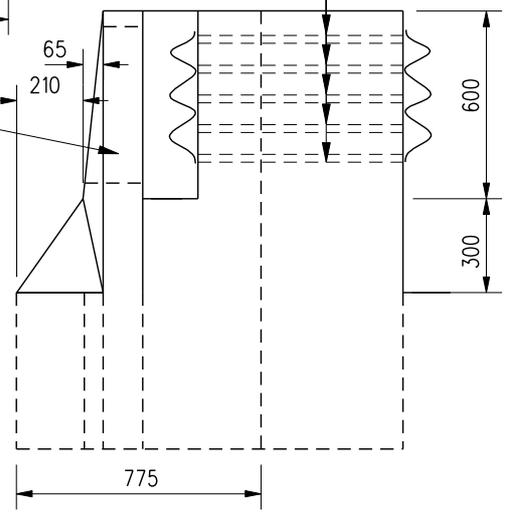
TB-04



ELEVATION



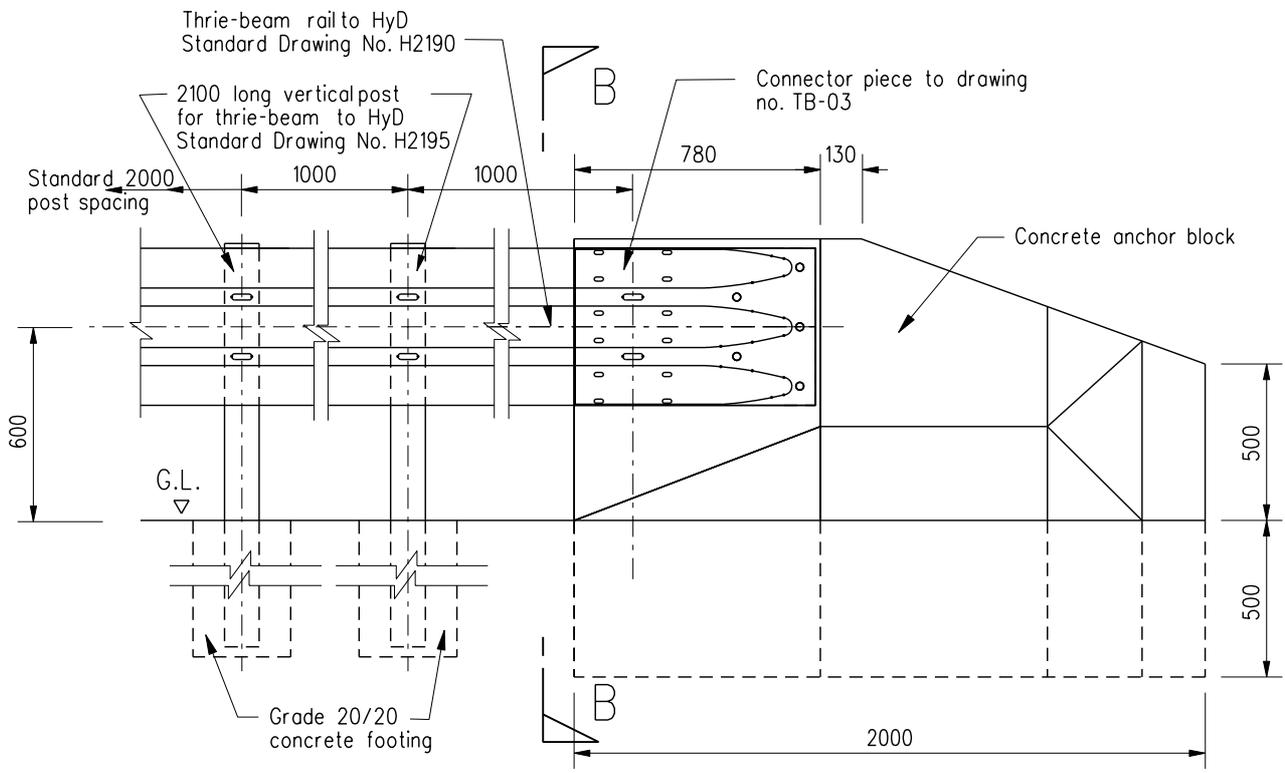
PLAN



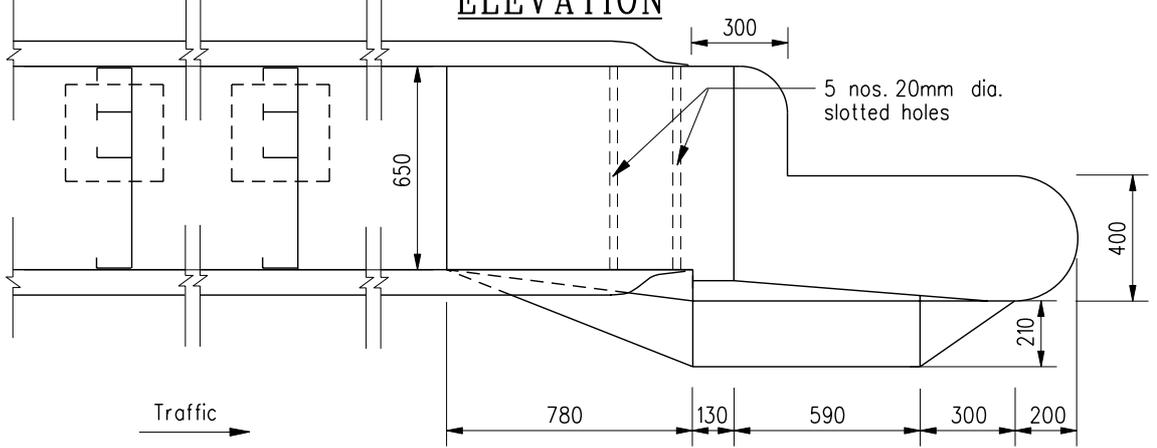
SECTION B-B

- Notes:
1. All dimensions are in millimetres.
 2. See notes on drawing no. TB-03.

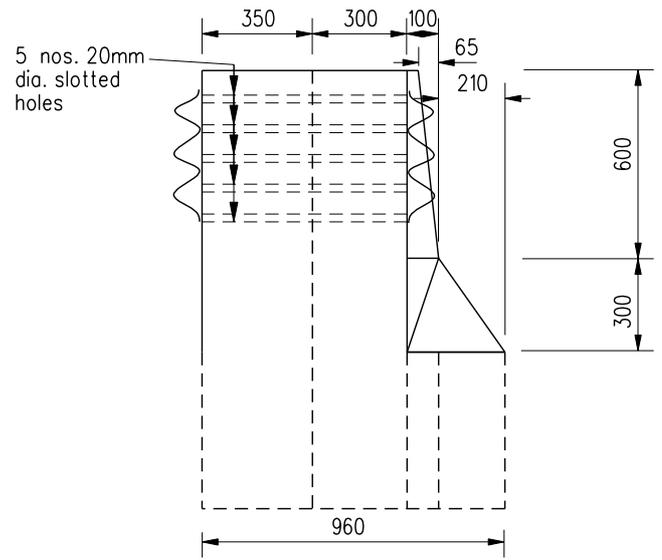
title CONNECTION DETAILS OF DOUBLE THRIE-BEAM BARRIER TO CONCRETE ANCHOR BLOCK AT LEADING TERMINAL	scale Not to Scale
	drawing no. TB-05



ELEVATION



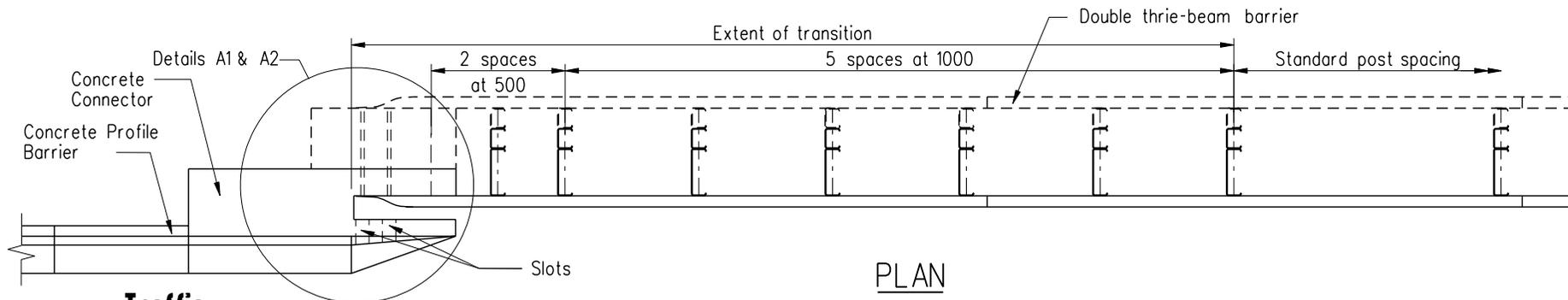
PLAN



SECTION B-B

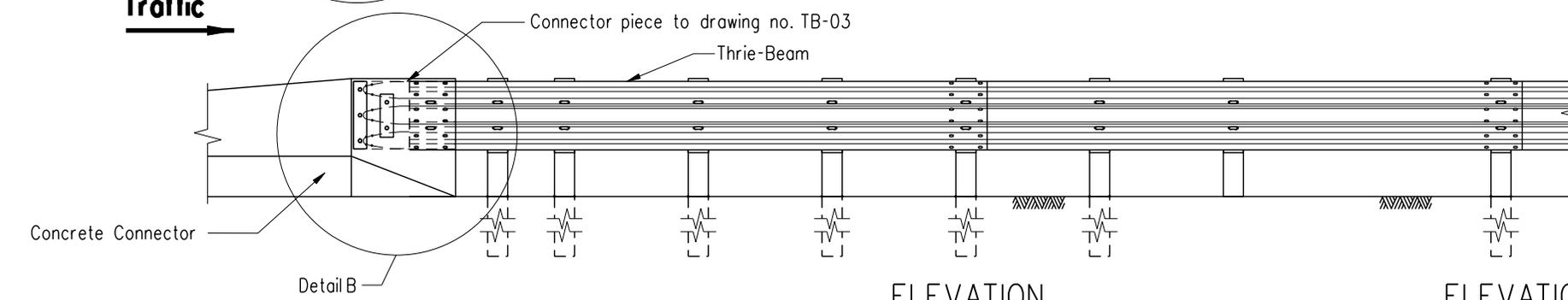
- Notes:
1. All dimensions are in millimetres.
 2. See notes on drawing no. TB-03.

title CONNECTION DETAILS OF DOUBLE THRIE-BEAM BARRIER TO CONCRETE ANCHOR BLOCK AT TRAILING TERMINAL	scale Not to Scale
	drawing no. TB-06



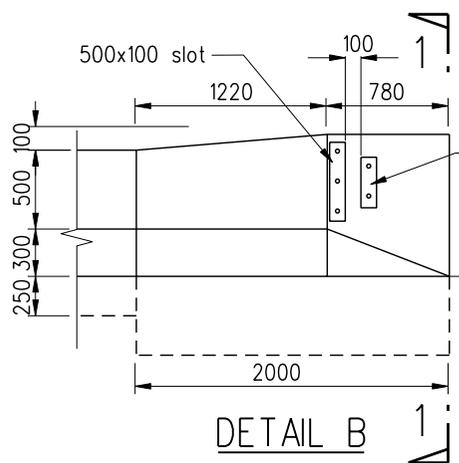
PLAN

- Notes:
1. Dimensions are in millimetres.
 2. See drawing no. TB-03 for details of thrie-beam connector piece. Connector piece shall be fixed to connector by five numbers M20 hot dip galvanised bolts.

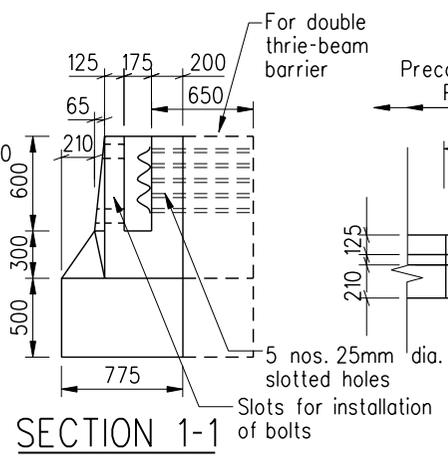


ELEVATION

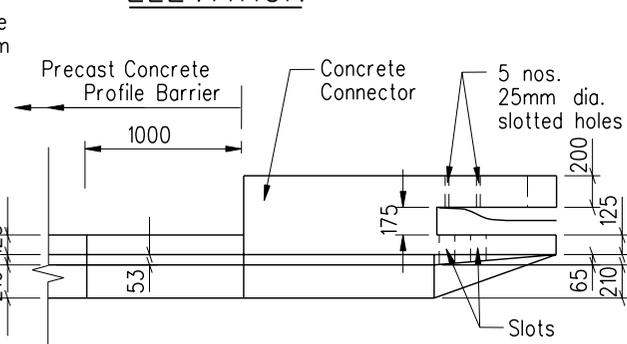
ELEVATION



DETAIL B

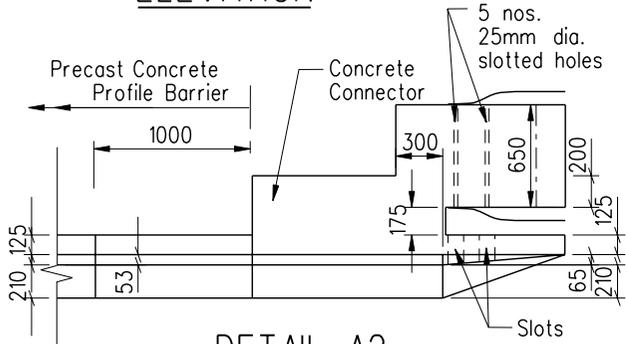


SECTION 1-1



DETAIL A1

(For single thrie-beam barrier)



DETAIL A2

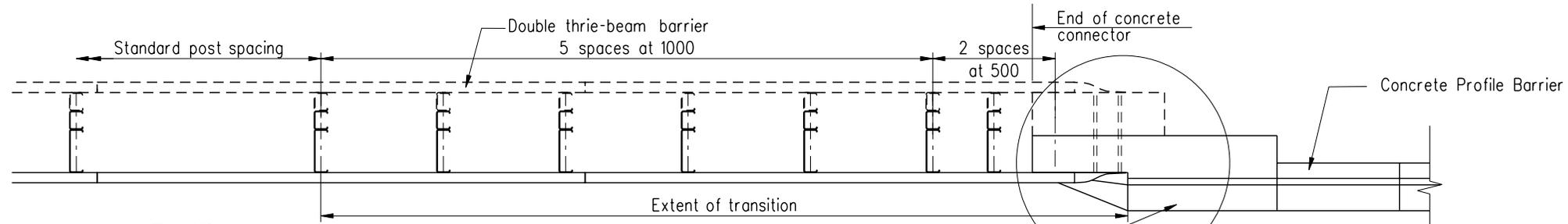
(For double thrie-beam barrier)

title

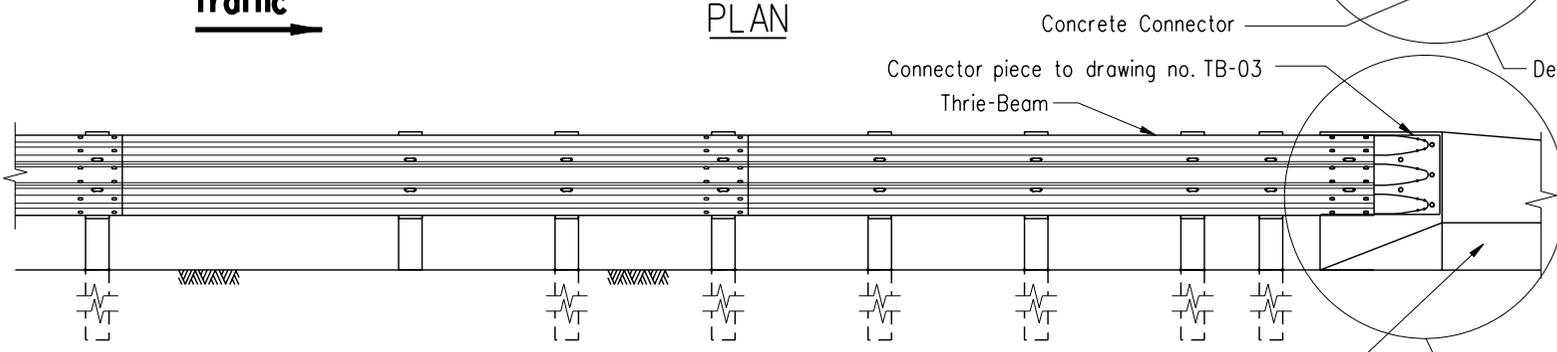
INTERFACE DETAILS OF THRIE-BEAM BARRIER TO CONCRETE PROFILE BARRIER (SHEET 1 OF 2)

scale Not to Scale

drawing no. TB-07

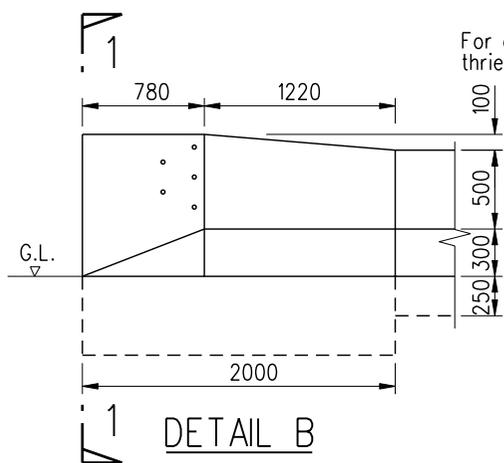


PLAN

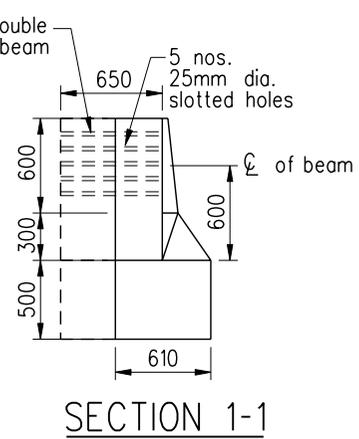


ELEVATION

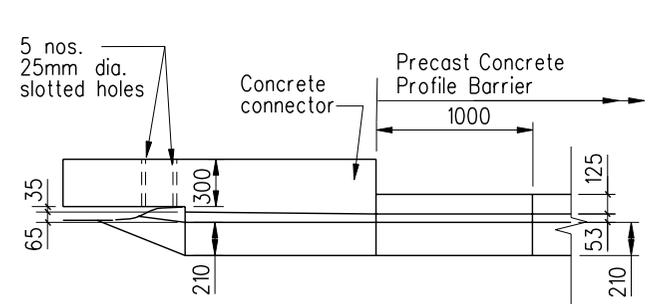
- Notes:
1. Dimensions are in millimetres.
 2. See drawing no. TB-03 for details of thrie-beam connector piece. Connector piece shall be fixed to concrete connector by five numbers M20 galvanised bolts.



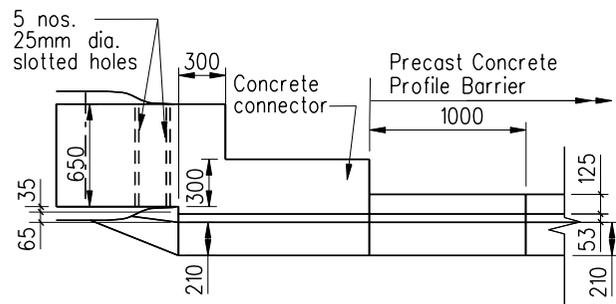
DETAIL B



SECTION 1-1



DETAIL A1
(For single thrie-beam barrier)



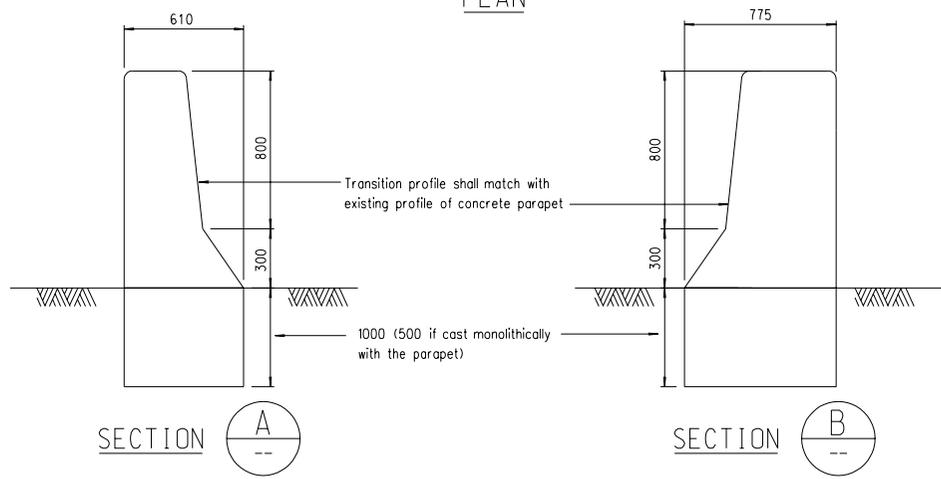
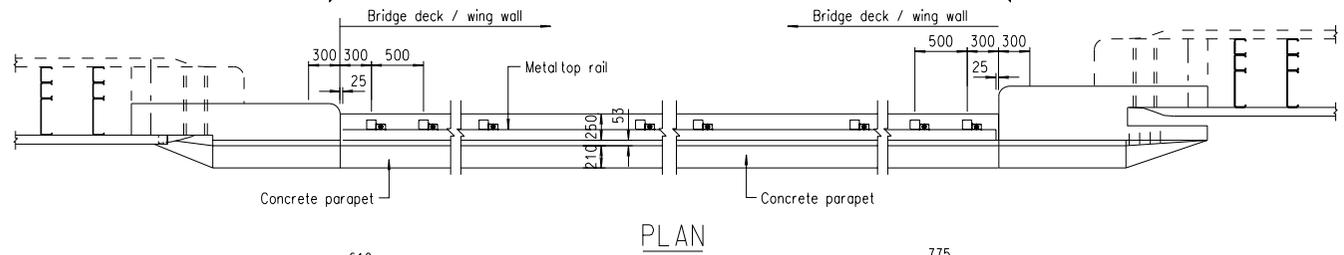
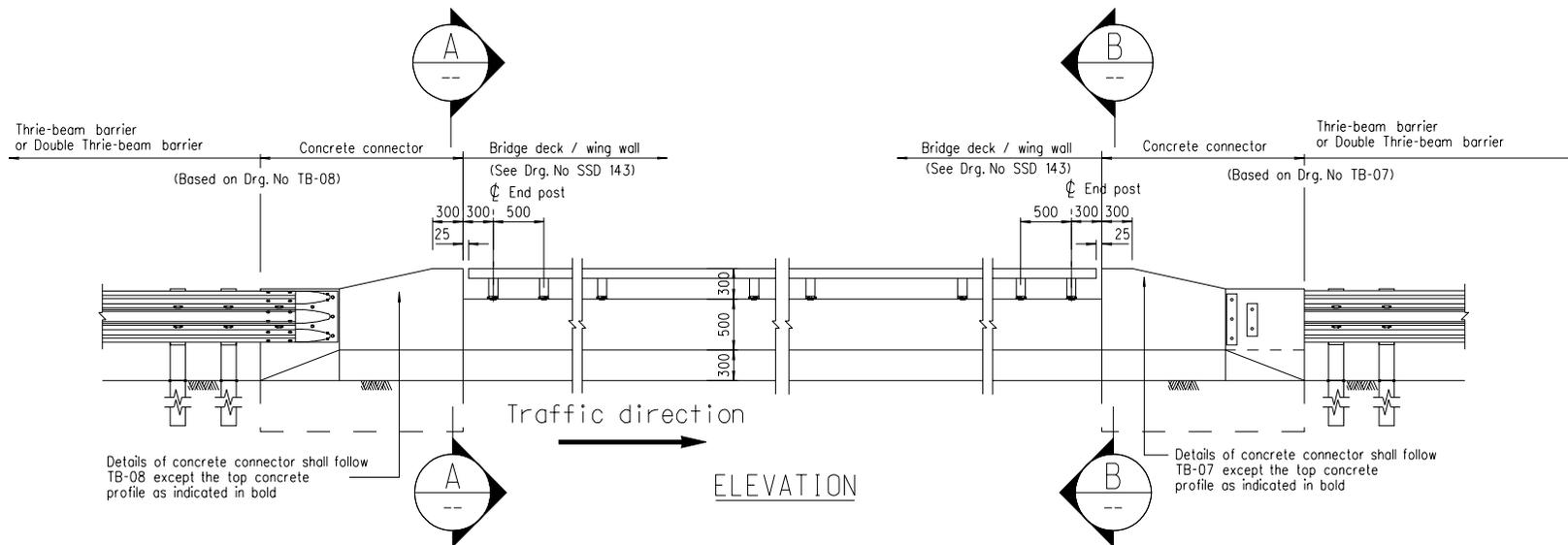
DETAIL A2
(For double thrie-beam barrier)

title

INTERFACE DETAILS OF THRIE-BEAM BARRIER TO CONCRETE PROFILE BARRIER (SHEET 2 OF 2)

scale Not to Scale

drawing no. TB-08

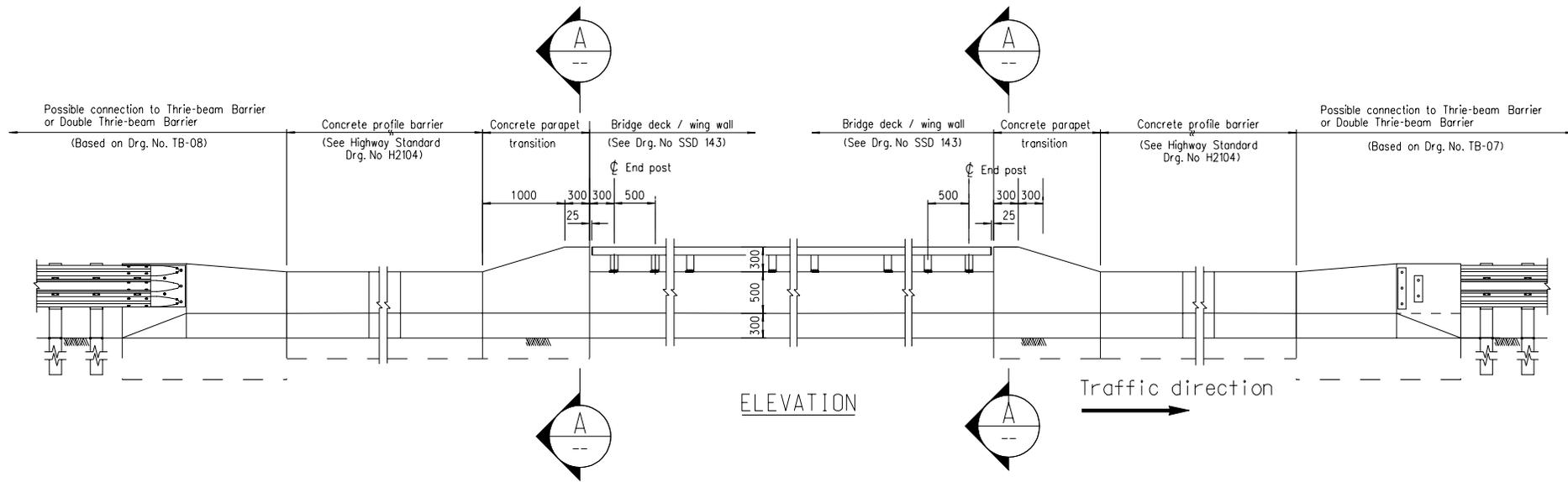


A	Sections A & B revised		Jan 07
REF.	REVISION	SIGNATURE	DATE

title

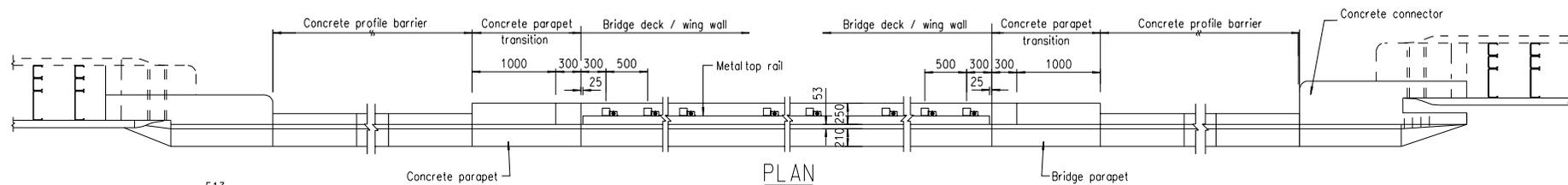
DIRECT CONNECTION OF A CONCRETE VEHICLE PARAPET TO THRIE-BEAM BARRIER

scale	N. T. S.
drawing no.	TB-09A

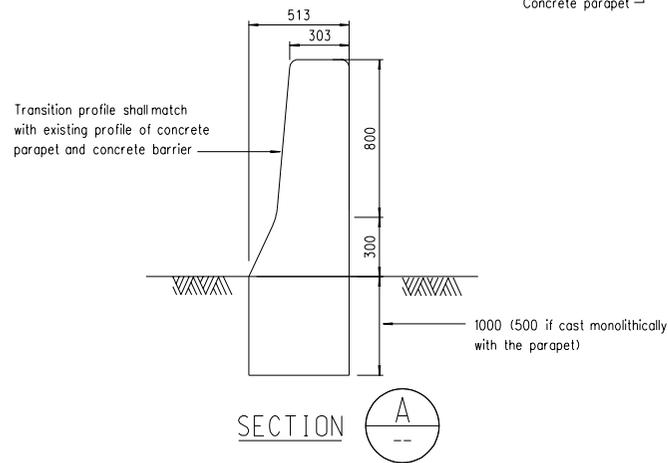


ELEVATION

Traffic direction →



PLAN



SECTION

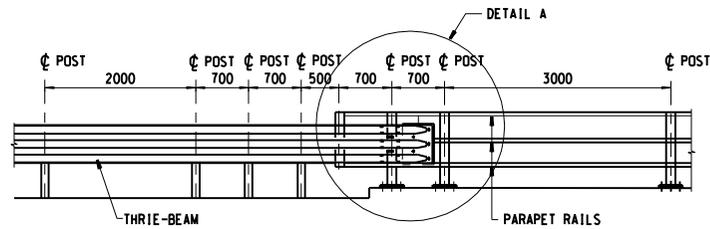
A	Section A revised		Jan 07
REF.	REVISION	SIGNATURE	DATE

title

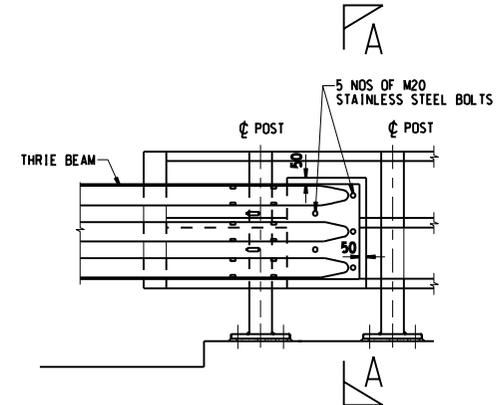
CONNECTION OF A CONCRETE VEHICLE PARAPET TO CONCRETE PROFILE BARRIER

scale
N. T. S.

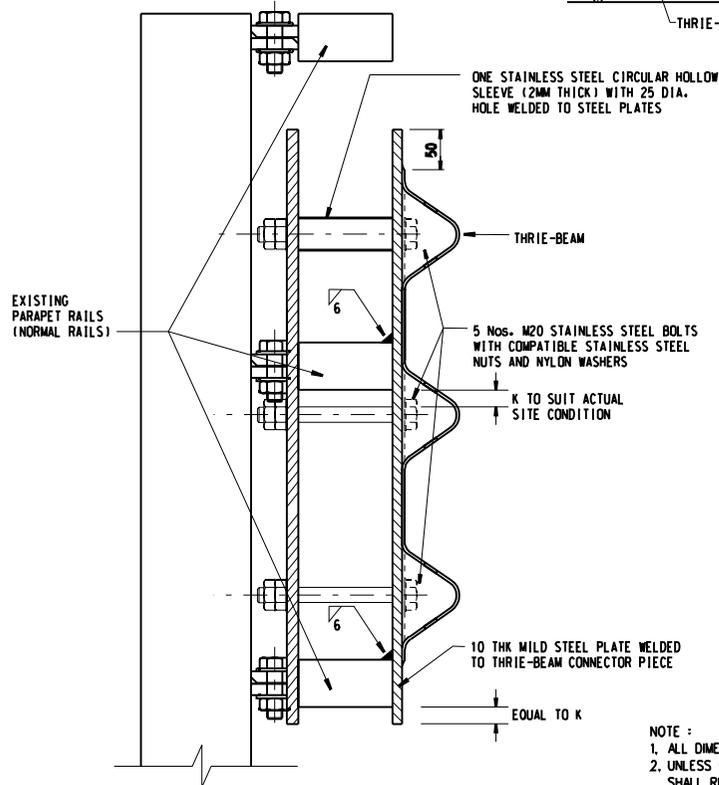
drawing no.
TB-10A



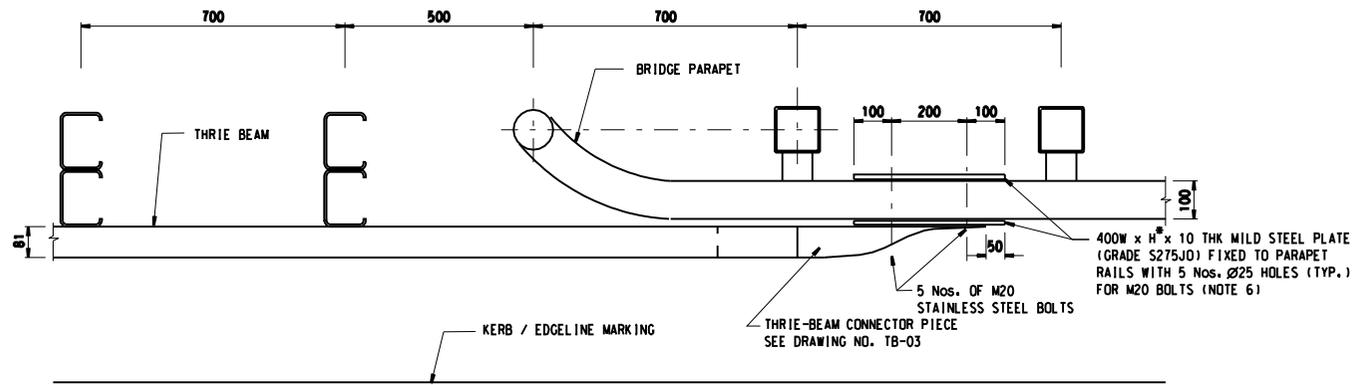
FRONT ELEVATION



DETAIL A



SECTION A-A



PLAN OF CONNECTOR DETAIL

NOTE :

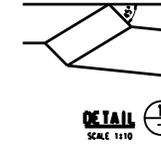
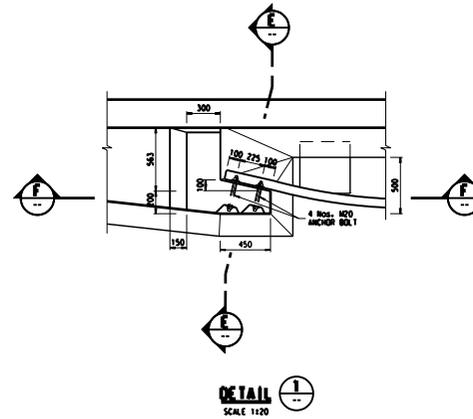
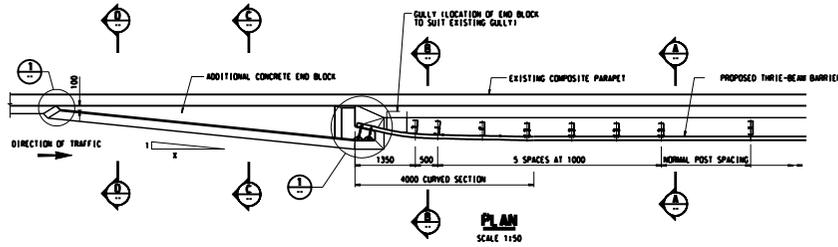
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. UNLESS OTHERWISE SPECIFIED IN THE DRAWING, ALL DETAILS OF STEEL VEHICLE PARAPET SHALL REFER TO DRAWING NO. SSD 141.
3. ALL MILD STEEL PLATES SHALL BE HOT DIP GALVANIZED TO BS EN ISO 1461 OR EQUIVALENT.
4. STAINLESS STEEL BOLTS AND NUTS SHALL BE GRADE A2-70 TO BE BS EN ISO 3506-1 AND BS EN ISO 3506-2.
5. A NYLON OR OTHER APPROVED PLASTIC WASHER SHALL BE PROVIDED AT EVERY INTERFACE BETWEEN STAINLESS STEEL AND GALVANIZED STEEL.
6. H* DENOTES VERTICAL HEIGHT TO SUIT ACTUAL SITE CONDITION.
7. BEAMS AND CONNECTOR PIECE SHALL BE LAPPED IN THE DIRECTION OF TRAFFIC.
8. DETAILS APPLIED TO BOTH TRAFFIC DIRECTIONS.

REF.	REVISION	SIGNATURE	DATE
C	Section A-A Revised		Jan 07
B	Section A-A Revised		Nov 06
A	Fillet Welds in Section A-A Deleted		Sep 06

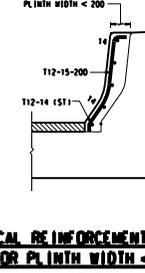
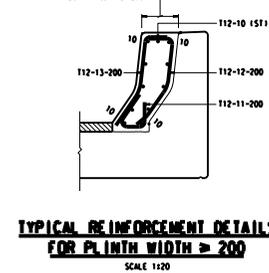
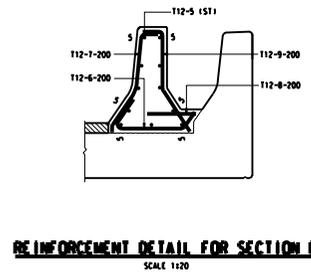
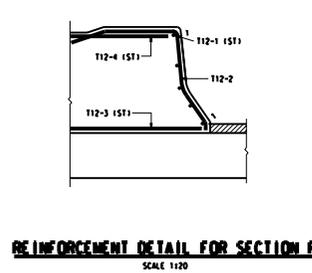
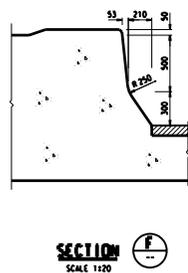
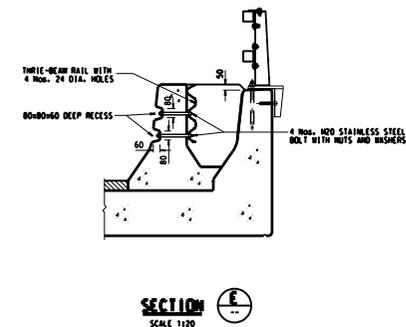
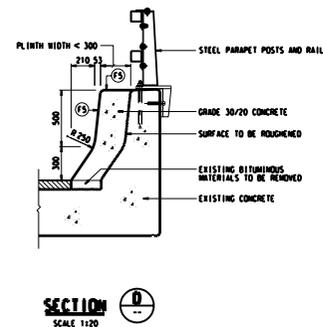
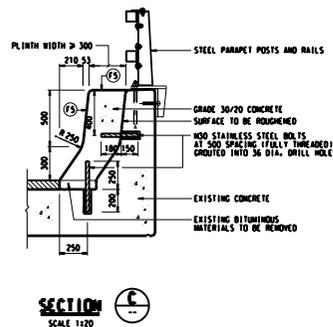
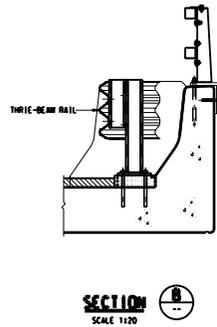
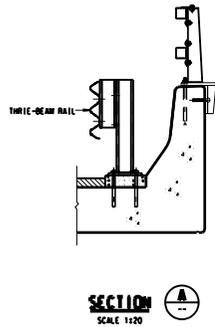
title
CONNECTION DETAILS OF THRIE-BEAM BARRIER TO L1 / L2 STEEL VEHICLE PARAPET - LEADING END (TRAILING END AS WELL IF THERE IS SITE CONSTRAINT)

scale
 A Not to Scale

drawing no.
TB-11C



- NOTES:
- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
 - UNLESS OTHERWISE SPECIFIED, CONCRETE GRADE SHALL BE 30/20.
 - CONCRETE FINISHES.
 - ⊕ DENOTES CLASS OF SURFACE FINISH P.S. (P.F., P.S., U.S., U.S., U.S.) AS DESCRIBED IN SECTION 14 OF THE GENERAL SPECIFICATION.
 - ANY CONSTRUCTION JOINT OTHER THAN THOSE INDICATED SHALL BE SUBJECT TO THE ENGINEER'S APPROVAL.
 - ALL CONCRETE CORNERS SHALL HAVE 20:20 CHAMFER UNLESS OTHERWISE SPECIFIED.
 - MINIMUM CONCRETE COVER TO REINFORCEMENT SHALL BE 40.
 - REINFORCEMENT NOTATION:
 (A) SEQUENCE OF DESCRIPTION
 T20T10-1-150 I
 T - TOP
 B - BOTTOM
 WF - WEAR FACE
 FF - FAR FACE
 Y - LENGTH VARIES
 S1 - STRAIGHT
 S2 - SHAPE OF BAR SIMILAR
 - REQUIREMENTS FOR MINIMUM LAP LENGTH AND ANCHORAGE LENGTH SHALL BE IN ACCORDANCE WITH G.S..
 - THE FLARE RATE "Z" SHALL BE IN ACCORDANCE WITH THE TRANSPORT DESIGN AND PLANNING MANUAL.
 - HORIZONTAL TRAFFIC CLEARANCE SHALL BE IN ACCORDANCE WITH TRANSPORT DESIGN AND PLANNING MANUAL.



REDUCED SCALE COPY

B & S SKETCH REF. No. HSTOTH055-SK0011.DGN

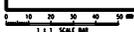
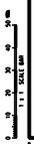
A	Drawing Title Revised	Nov 06
REF.	REVISION	SIGNATURE DATE

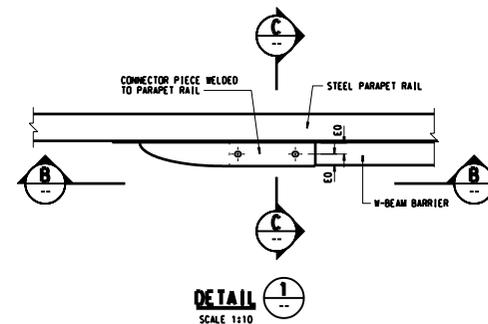
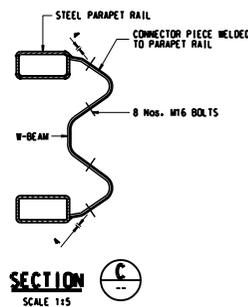
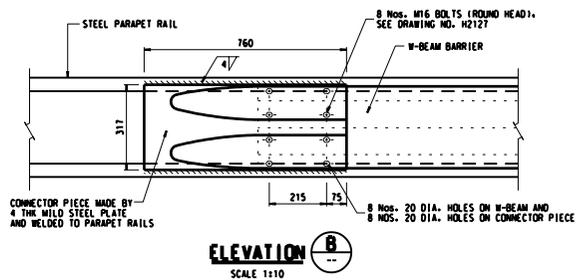
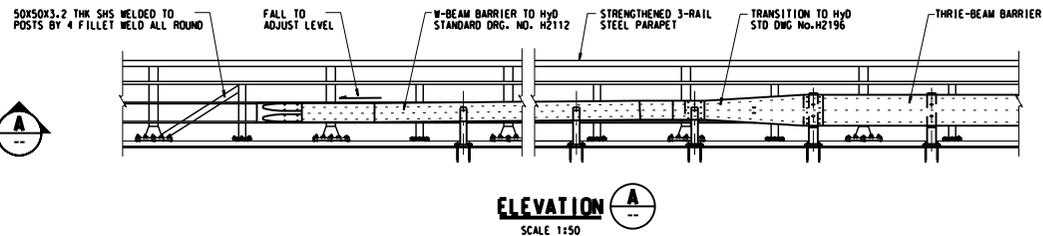
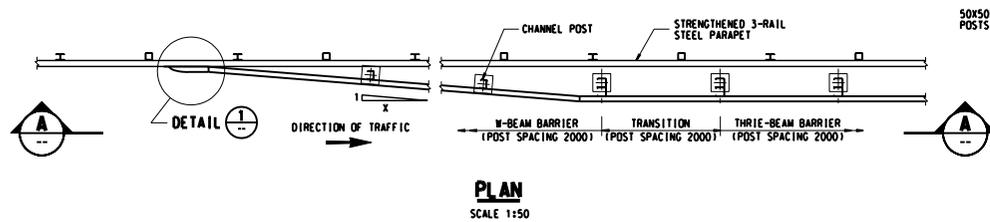
sketch title

sketch no.

THREE-BEAM FOR USE AS CUSHION - END TYPE I (FOR LEADING END ONLY)

TB-12A



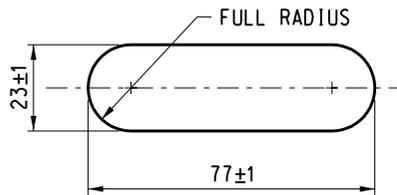


**THRIE-BEAM END DETAILS TYPE II
(LEADING / TRAILING ENDS SIMILAR)**

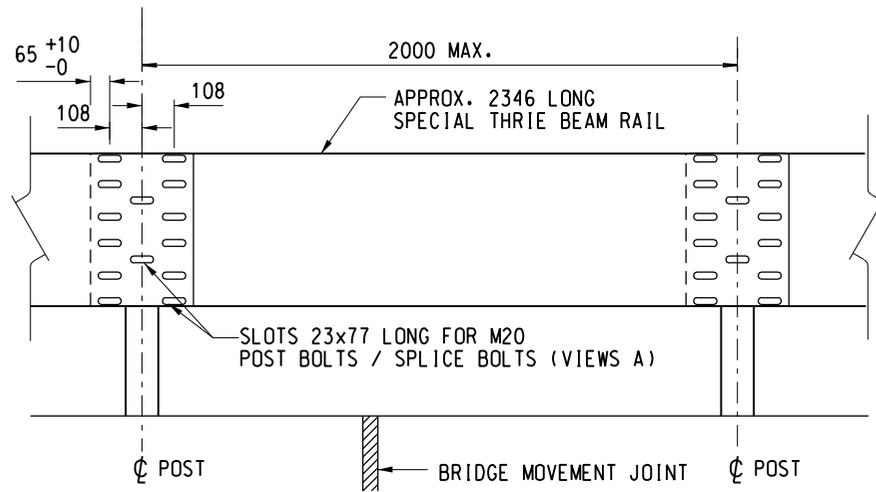
B	END DETAILS TYPE II REVISED AS FOR THE REVISIONS IN TB-13 & TB-19		Nov 06
A	END DETAILS TYPE II REVISED AS FOR THE REVISIONS IN TB-13 & TB-19 THRIE-BEAM END TYPE IV DETETED		Sep 06
REF.	REVISION	SIGNATURE	DATE

THRIE-BEAM FOR USE AS CUSHION - END TYPE II

scale
drawing no. TB-13B



VIEW A
SCALE 1:2



ELEVATION OF THRIE-BEAM
SCALE 1:25

NOTES:

1. UNLESS OTHERWISE SHOWN IN THIS SKETCH, DETAILS OF THRIE BEAM SHALL REFER TO DRG. NOS. H2190, H2191, H2192, H2193, H2194, H2195, H2196 AND H2197.
2. ALL BOLTS SHALL BE SET AT CENTRES OF THE SLOTS.

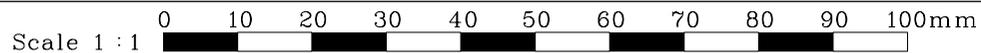
B & S SKETCH REF.No. HSTOTH009-SK1881.DGN

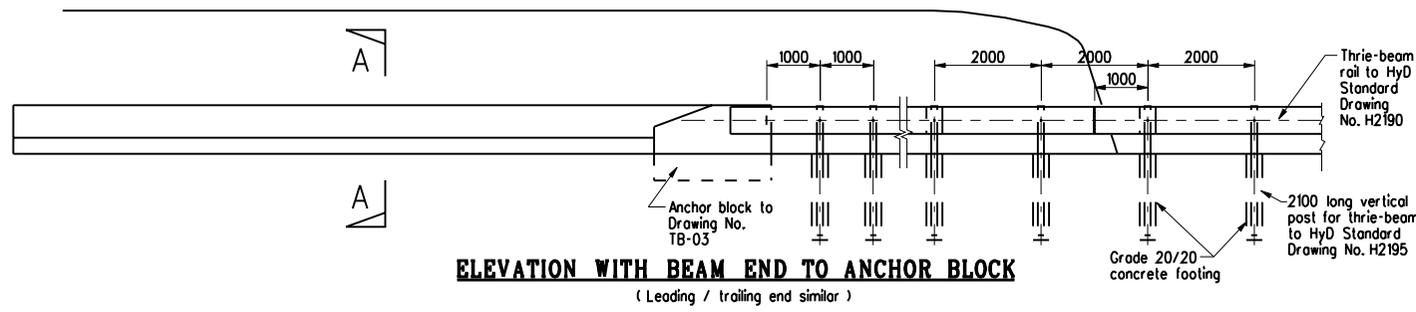
sketch title

DETAILS OF THRIE-BEAM AT BRIDGE MOVEMENT JOINT

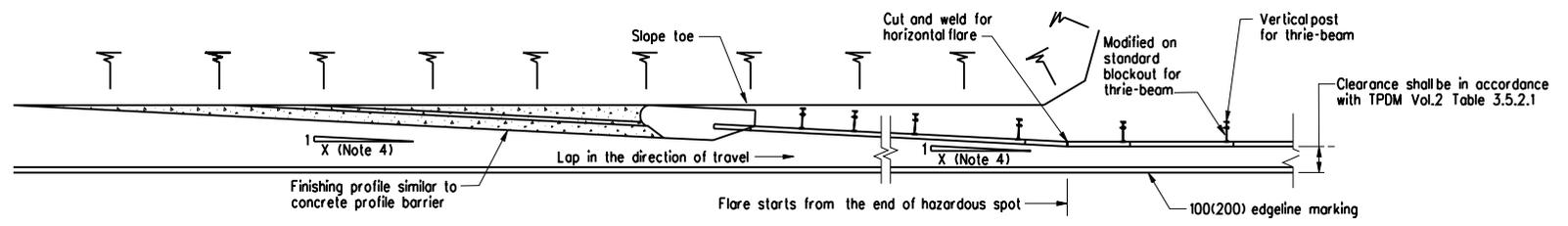
sketch no.

TB-14

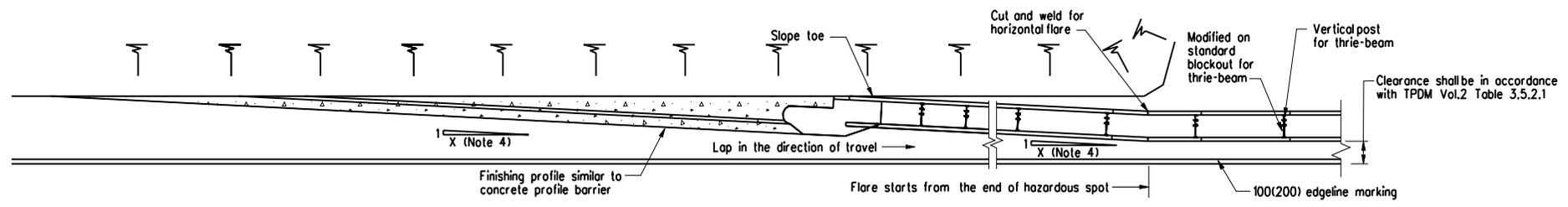




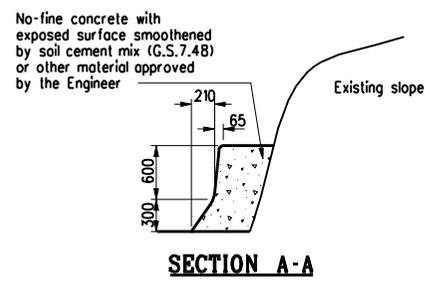
ELEVATION WITH BEAM END TO ANCHOR BLOCK
(Leading / trailing end similar)



PLAN WITH BEAM END TO ANCHOR BLOCK
(Modified on standard thrie-beam barrier)



PLAN WITH BEAM END TO ANCHOR BLOCK
(Thrie-beam barrier with additional rail at the back)



- Notes:
1. Details apply to roads of speed limit 70kph or above.
 2. All dimensions are in millimeters.
 3. Where the concrete footing is located in block paved footpath, the footing should be made of colour concrete with colour to tie with that of the paving blocks.
 4. Flare rate X refers to Table 3.9.3.2 of TPDM Vol.2 Chapter 3.

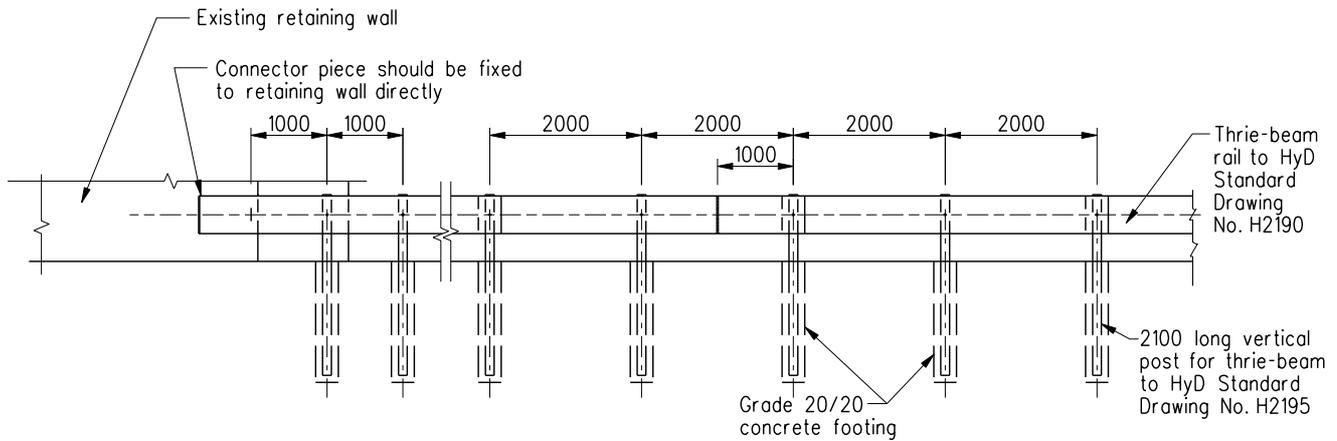
B	Notes 5 & 6 deleted		Jan 07
A	Revise the arrangement to eliminate excavation of slope toe. Title amended		Nov 06
REF.	REVISION	SIGNATURE	DATE

title

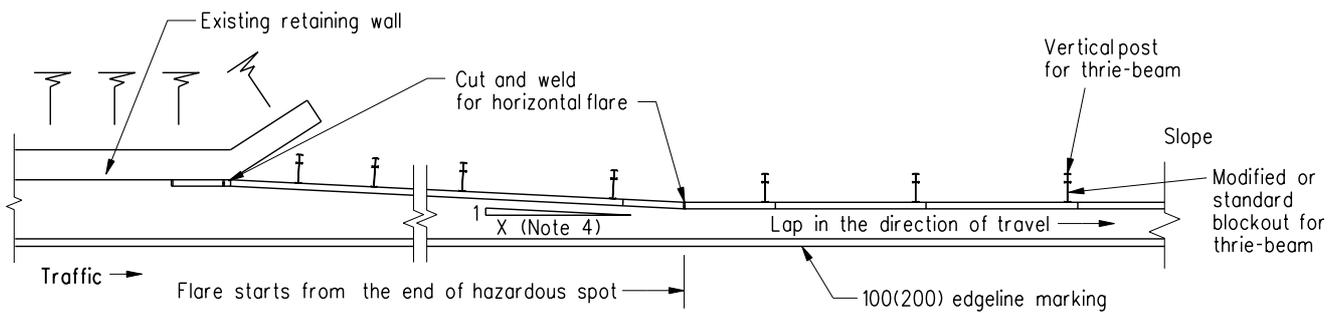
END OF THRIE-BEAM BARRIER TO BE BLENDED WITH UPHILL SLOPE

scale Not to Scale

drawing no. **TB-15B**



ELEVATION WITH BEAM END ANCHORED TO RETAINING WALL
(LEADING AND TRAILING ENDS SIMILAR)



PLAN WITH BEAM END ANCHORED TO RETAINING WALL
(LEADING AND TRAILING ENDS SIMILAR)

Notes:

1. Details apply to roads of speed limit 70kph or above.
2. All dimensions are in millimeters.
3. Where the concrete footing is located in block paved footpath, the footing should be made of colour concrete with colour to tie with that of the paving blocks.
4. Flare rate X refers to Table 3.9.3.2 of TPDM Vol2 Chapter 3.

title

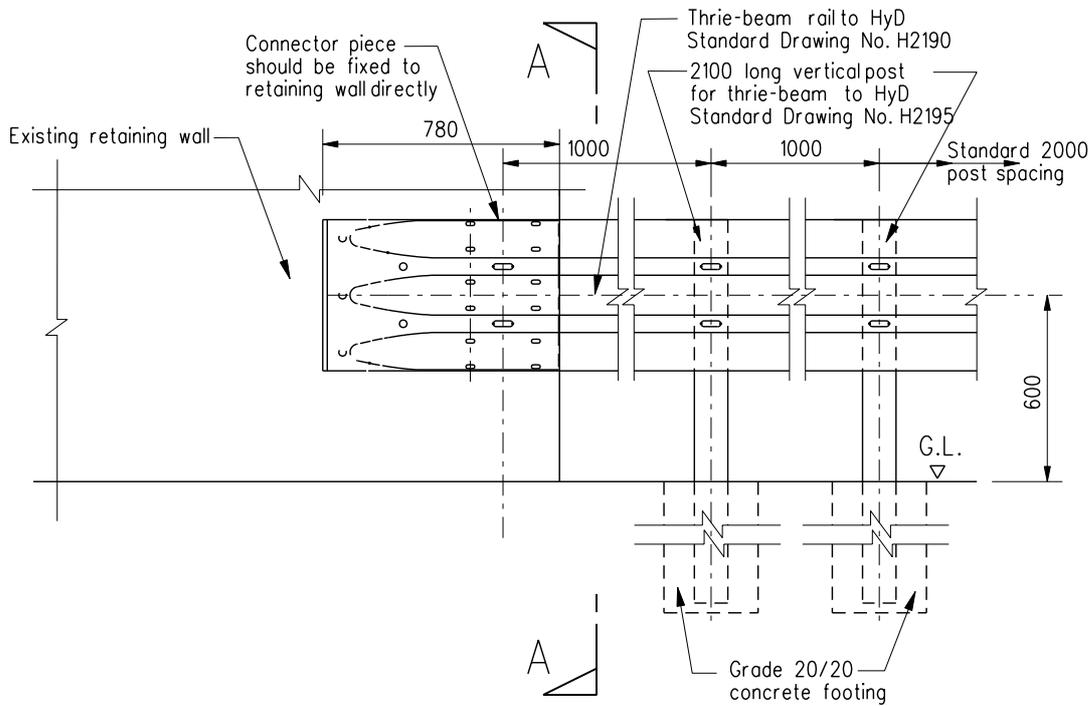
**TERMINAL OF THRIE-BEAM
 BARRIER ANCHORED TO
 RETAINING WALL**

scale

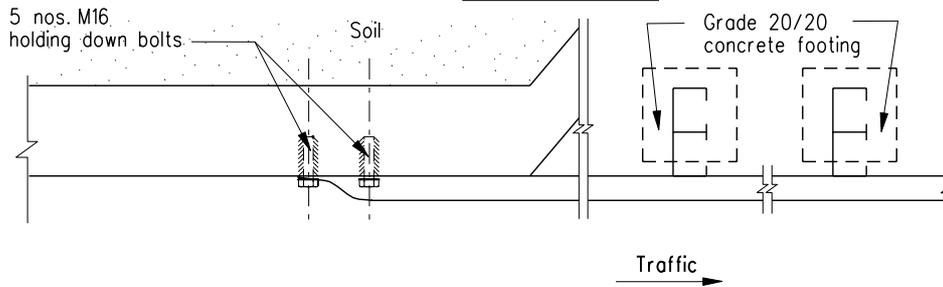
Not to Scale

drawing no.

TB-17



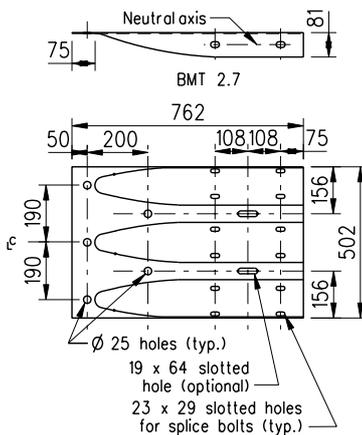
ELEVATION



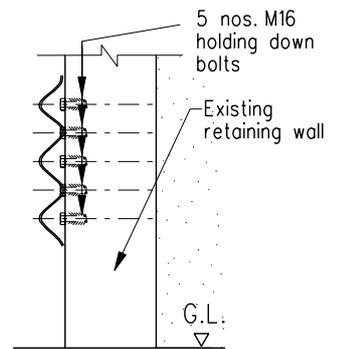
PLAN

Notes:

1. All dimensions are in millimetres.
2. See HyD Standard Drawing No. H2197 for details of splice bolts connecting beam rail and connector piece.
3. Connector piece shall be fixed to retaining wall by five numbers M16 stainless steel holding down bolts with compatible stainless steel washer and nylon or other approved plastic washer.
4. Connector piece shall be formed from steel grade HA350 in accordance with AS/NZS 1594 or others approved by the Engineer.
5. Except where tolerances are shown in the drawings, all dimensions are subject to manufacturer's tolerances and the approval of the Engineer. Dimensional tolerances for all components, if not shown or implied, shall be consistent with the proper functioning of the component, involving its appearance and accepted manufactured practices.



CONNECTOR PIECE FOR THRIE-BEAM



SECTION A-A

title

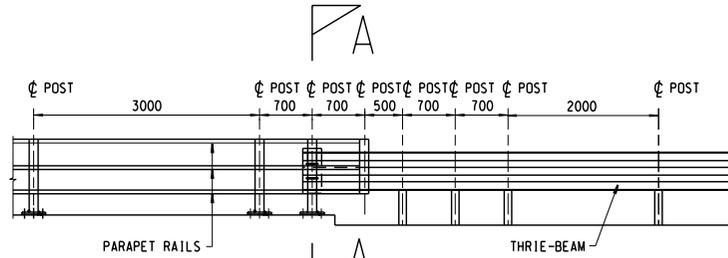
CONNECTION DETAILS OF THRIE-BEAM BARRIER TO RETAINING WALL

scale

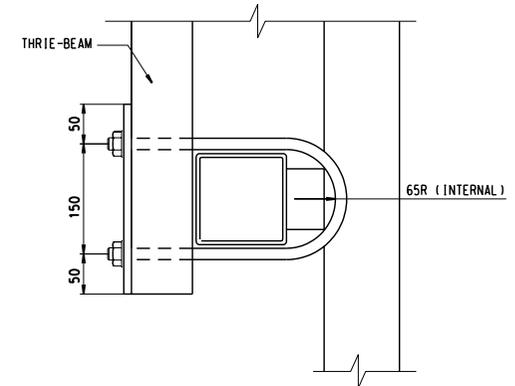
No to Scale

drawing no.

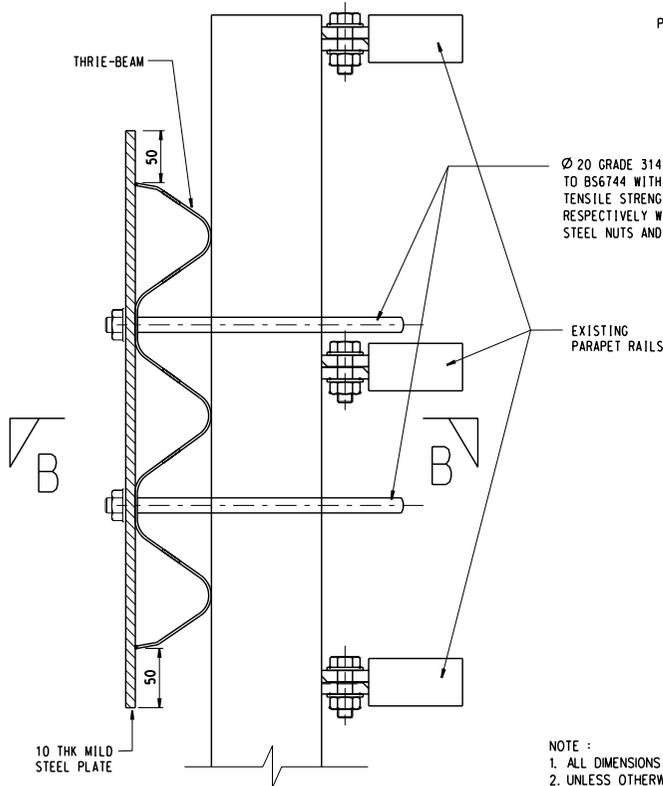
TB-18



FRONT ELEVATION



SECTION B-B



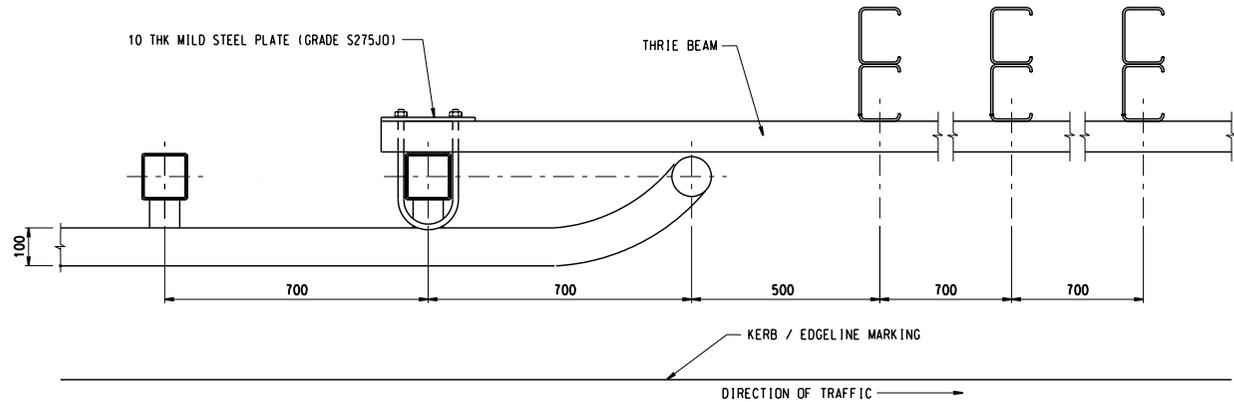
SECTION A-A

Ø 20 GRADE 314 STAINLESS STEEL PLAIN BAR TO BS6744 WITH MINIMUM YIELD STRENGTH AND TENSILE STRENGTH OF 450 N/mm² AND 700 N/mm² RESPECTIVELY WITH COMPATIBLE STAINLESS STEEL NUTS AND NYLON WASHER

EXISTING PARAPET RAILS

10 THK MILD STEEL PLATE (GRADE S275J0)

THRIE BEAM



PLAN OF CONNECTOR DETAIL

- NOTE :
1. ALL DIMENSIONS ARE IN MILLIMETRES.
 2. UNLESS OTHERWISE SPECIFIED IN THE DRAWING, ALL DETAILS OF STEEL VEHICLE PARAPET SHALL REFER TO DRAWING NO. SSD 141.
 3. ALL MILD STEEL PLATES SHALL BE HOT DIP GALVANIZED TO BS EN ISO 1461 OR EQUIVALENT.
 4. STAINLESS STEEL BOLTS AND NUTS SHALL BE GRADE A2-70 TO BS EN ISO 3506-1 AND BS EN ISO 3506-2.
 5. A NYLON OR OTHER APPROVED PLASTIC WASHER SHALL BE PROVIDED AT EVERY INTERFACE BETWEEN STAINLESS STEEL AND GALVANIZED STEEL.
 6. BEAMS AND CONNECTOR PIECE SHALL BE LAPPED IN THE DIRECTION OF TRAFFIC.

REF.	REVISION	SIGNATURE	DATE
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title

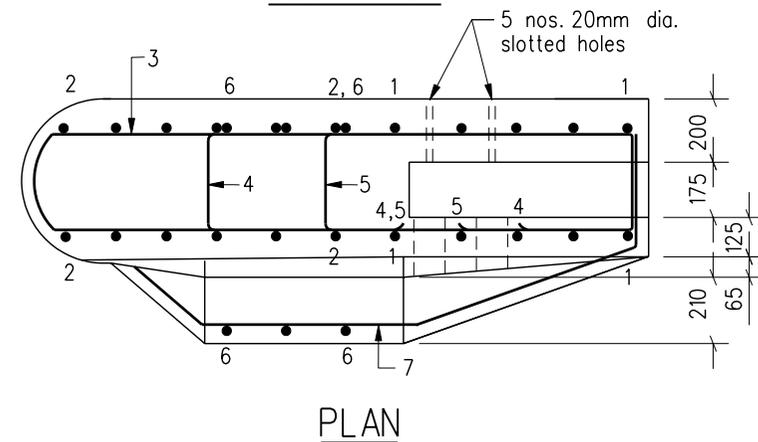
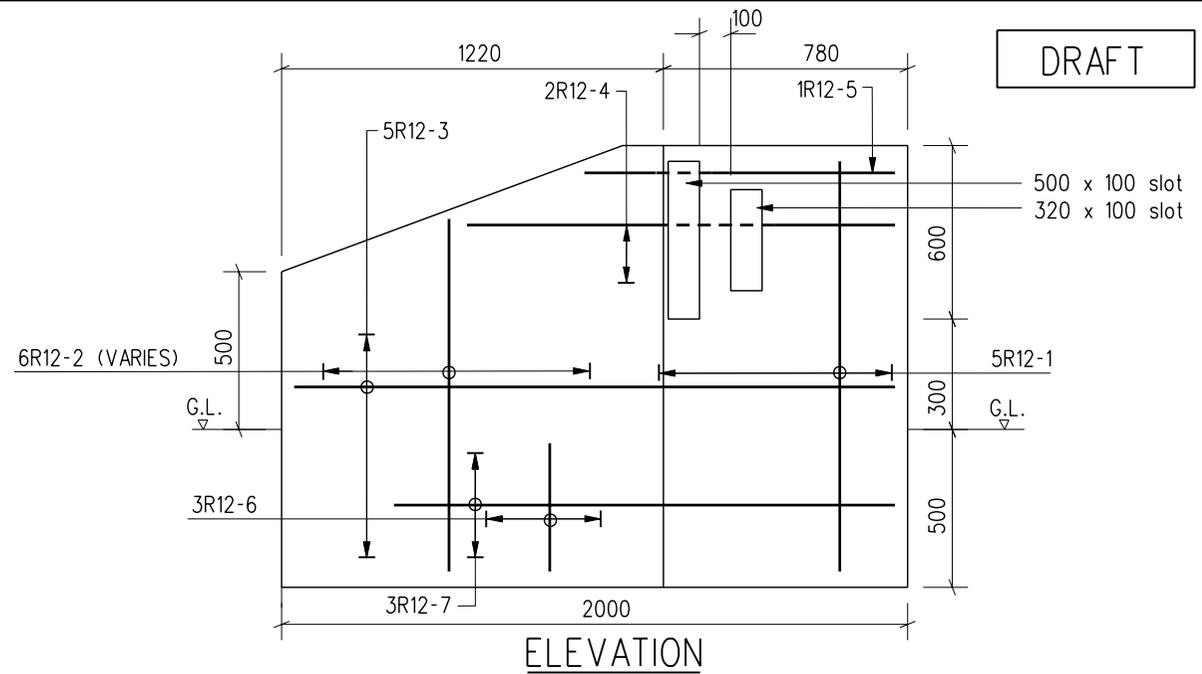
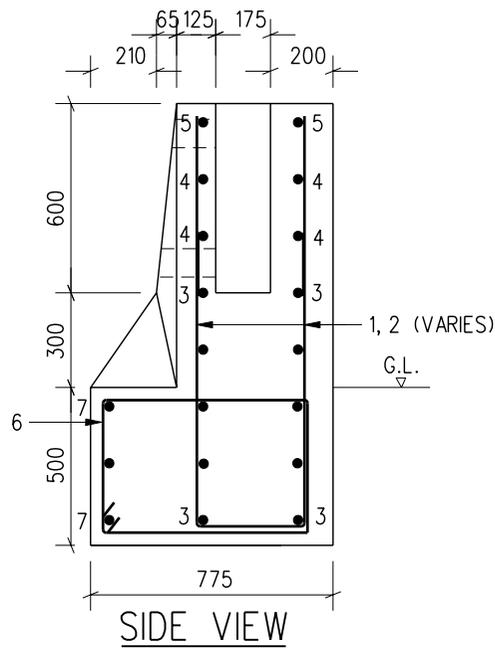
CONNECTION DETAILS OF THRIE-BEAM BARRIER TO L1 / L2 STEEL VEHICLE PARAPET - TRAILING END

scale

A Not to Scale

drawing no.

TB-20



Notes:

1. Dimensions are in millimetres.
2. This drawing shall be read in conjunction to drg. no. TB-03.
3. All concrete to be grade 30/20.
4. 40 cover to reinforcement.
5. Concrete surface shall be class F5 for formed finishes and class U5 for unformed finishes.

title

REINFORCEMENT DETAILS OF THRIE-BEAM
CONCRETE ANCHOR BLOCK
AT LEADING TERMINAL

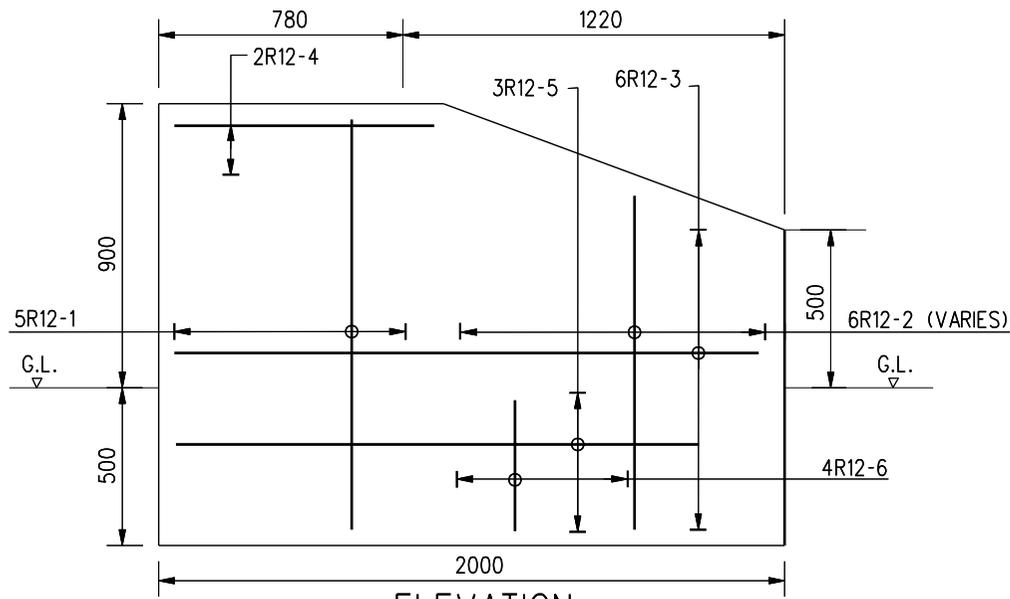
scale

Not to Scale

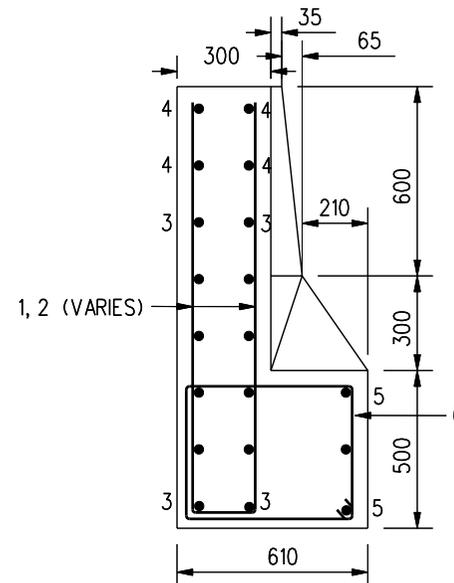
drawing no.

TB-03(R)

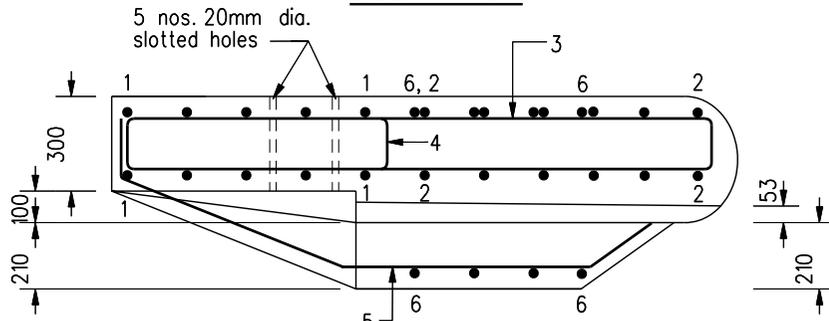
DRAFT



ELEVATION



SIDE VIEW



PLAN

Notes:

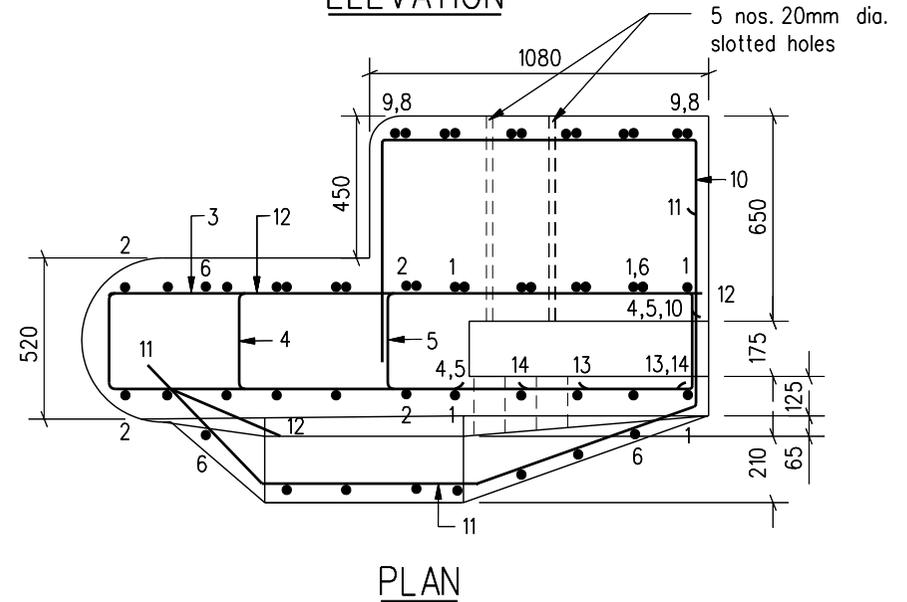
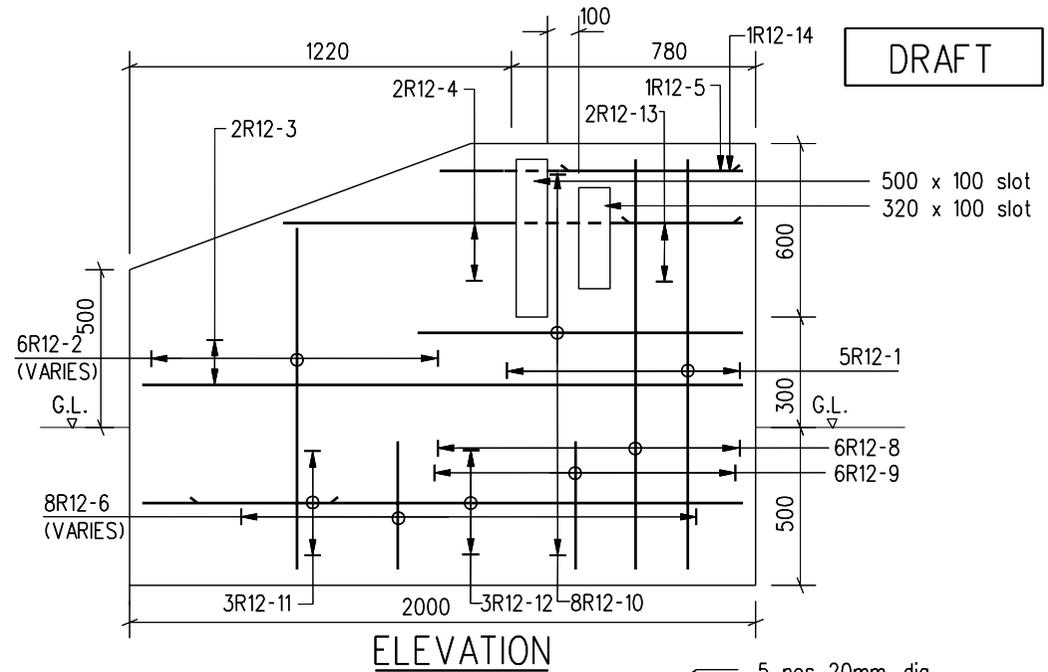
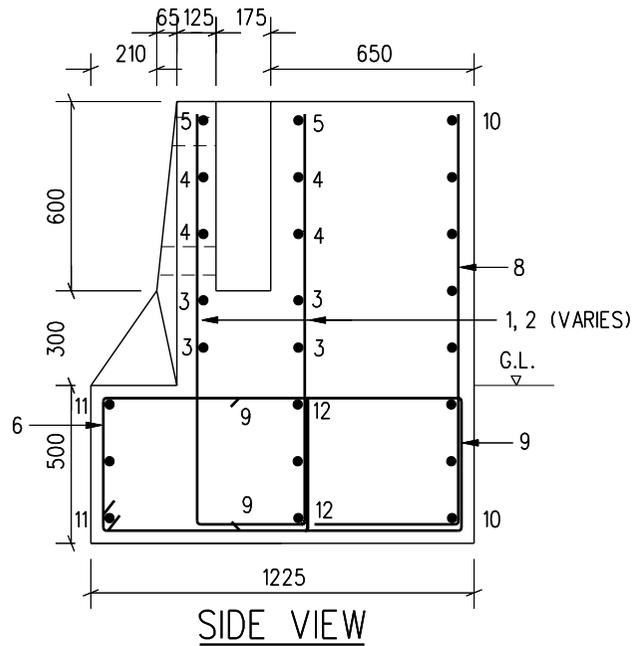
1. Dimensions are in millimetres.
2. This drawing shall be read in conjunction to drg. no. TB-04.
3. All concrete to be grade 30/20.
4. 40 cover to reinforcement.
5. Concrete surface shall be class F5 for formed finishes and class U5 for unformed finishes.

title

REINFORCEMENT DETAILS OF THRIE-BEAM
CONCRETE ANCHOR BLOCK
AT TRAILING TERMINAL

scale Not to Scale

drawing no. TB-04(R)



Notes:

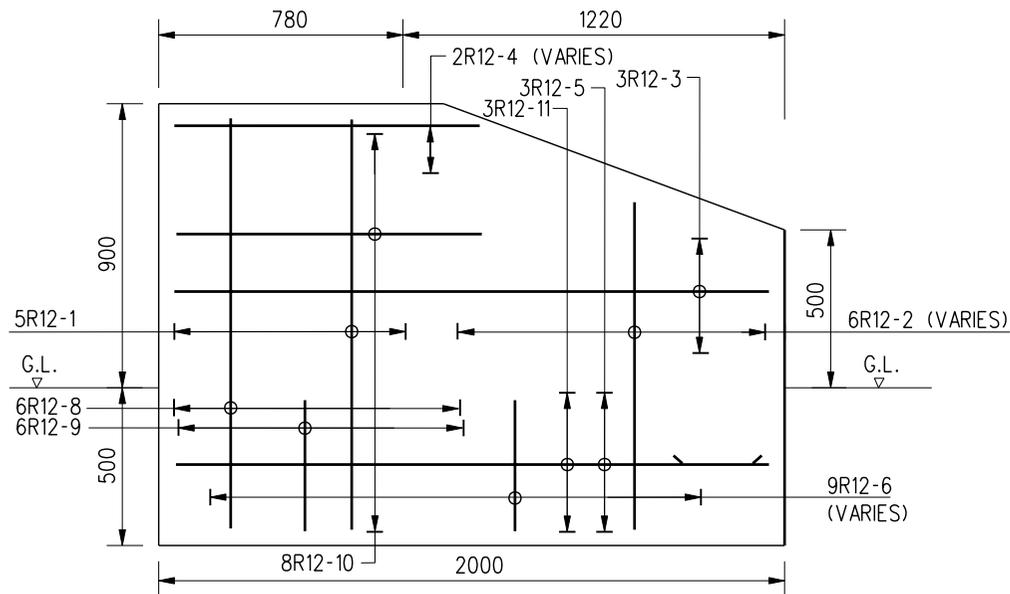
1. Dimensions are in millimetres.
2. This drawing shall be read in conjunction to drg. no. TB-05.
3. All concrete to be grade 30/20.
4. 40 cover to reinforcement.
5. Concrete surface shall be class F5 for formed finishes and class U5 for unformed finishes.

title

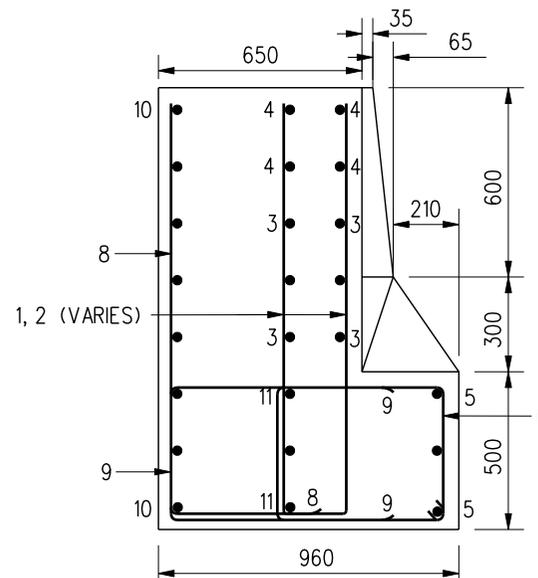
REINFORCEMENT DETAILS OF DOUBLE THRIE-BEAM CONCRETE ANCHOR BLOCK AT LEADING TERMINAL

scale Not to Scale

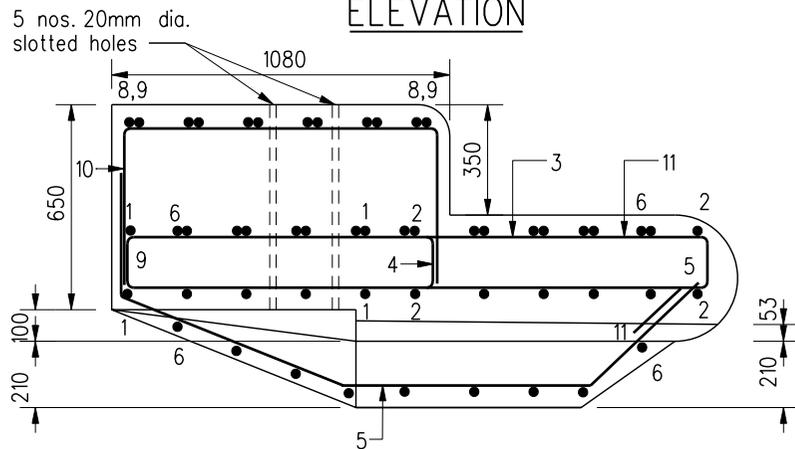
drawing no. TB-05(R)



ELEVATION



SIDE VIEW



PLAN

Notes:

1. Dimensions are in millimetres.
2. This drawing shall be read in conjunction to drg. no. TB-06.
3. All concrete to be grade 30/20.
4. 40 cover to reinforcement.
5. Concrete surface shall be class F5 for formed finishes and class U5 for unformed finishes.

title

REINFORCEMENT DETAILS OF DOUBLE
THRIE-BEAM CONCRETE ANCHOR BLOCK
AT TRAILING TERMINAL

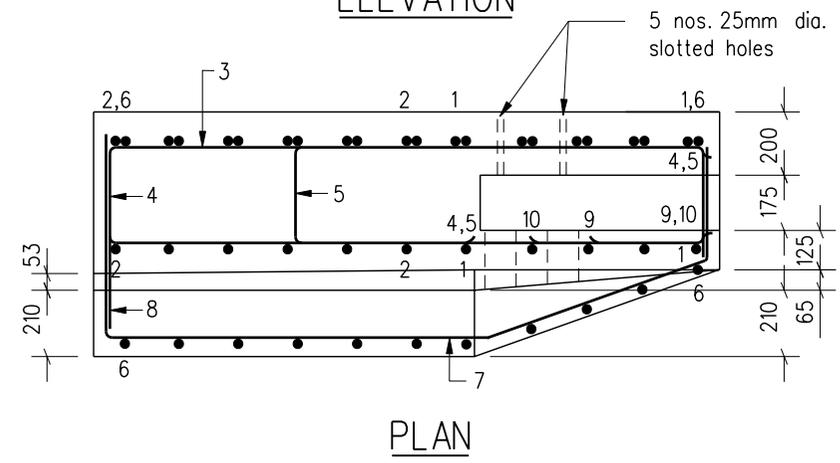
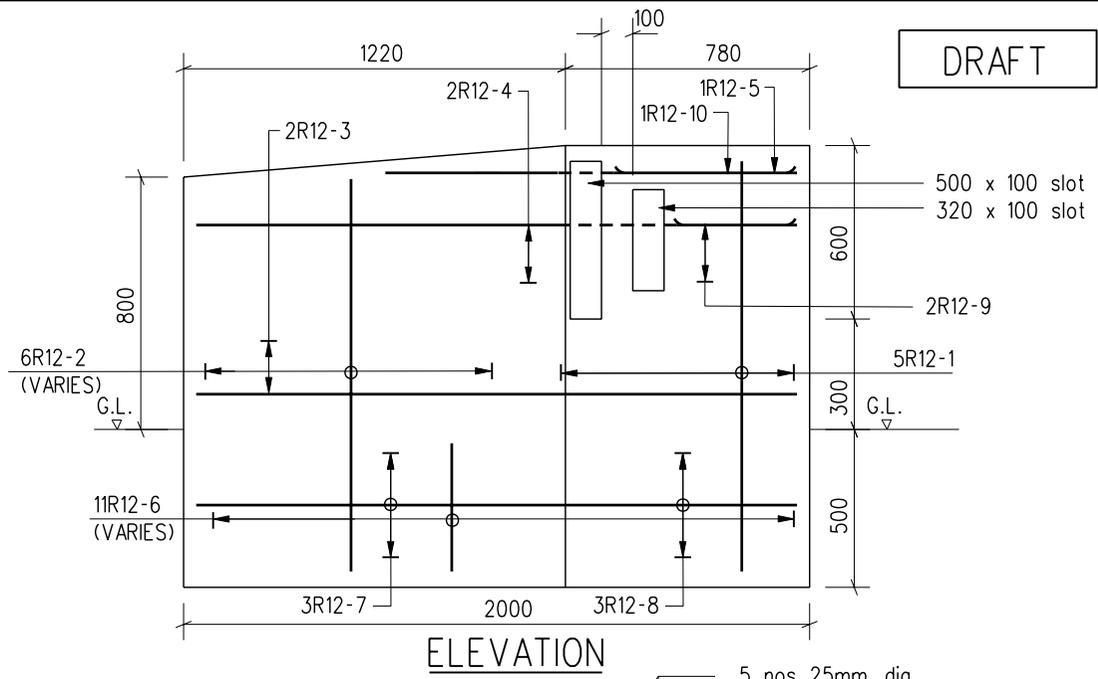
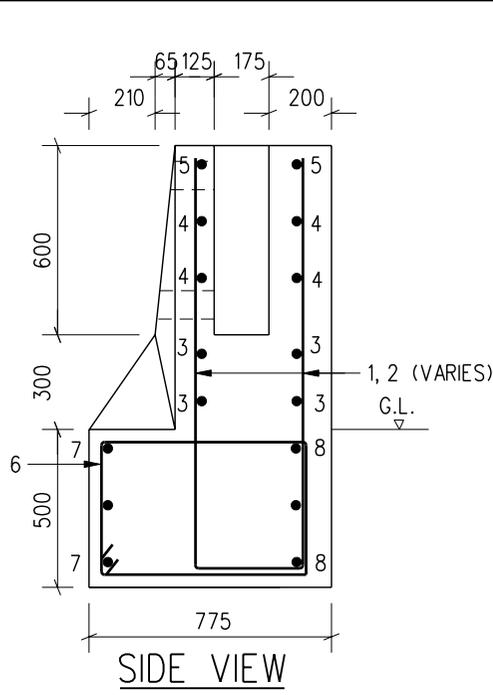
scale

Not to Scale

drawing no.

TB-06(R)

DRAFT



- Notes:
1. Dimensions are in millimetres.
 2. This drawing shall be read in conjunction to drg. no. TB-07.
 3. All concrete to be grade 30/20.
 4. 40 cover to reinforcement.
 5. Concrete surface shall be class F5 for formed finishes and class U5 for unformed finishes.

(FOR SINGLE THRIE-BEAM BARRIER)

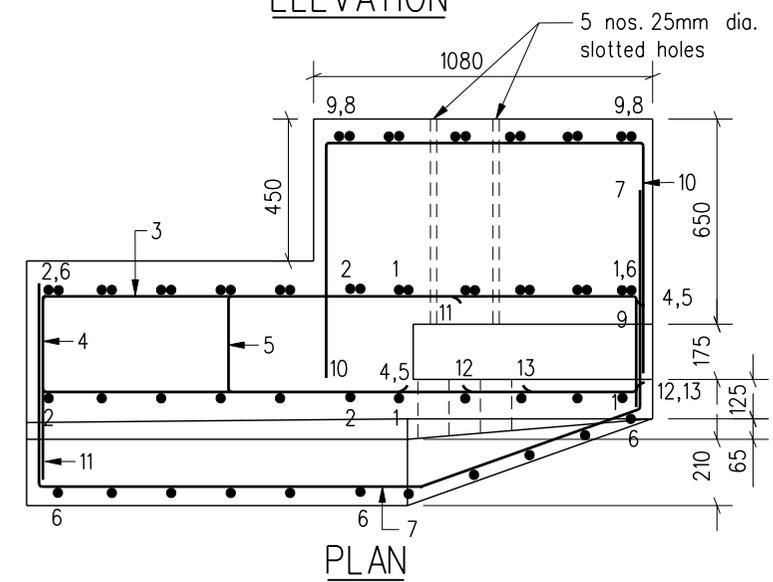
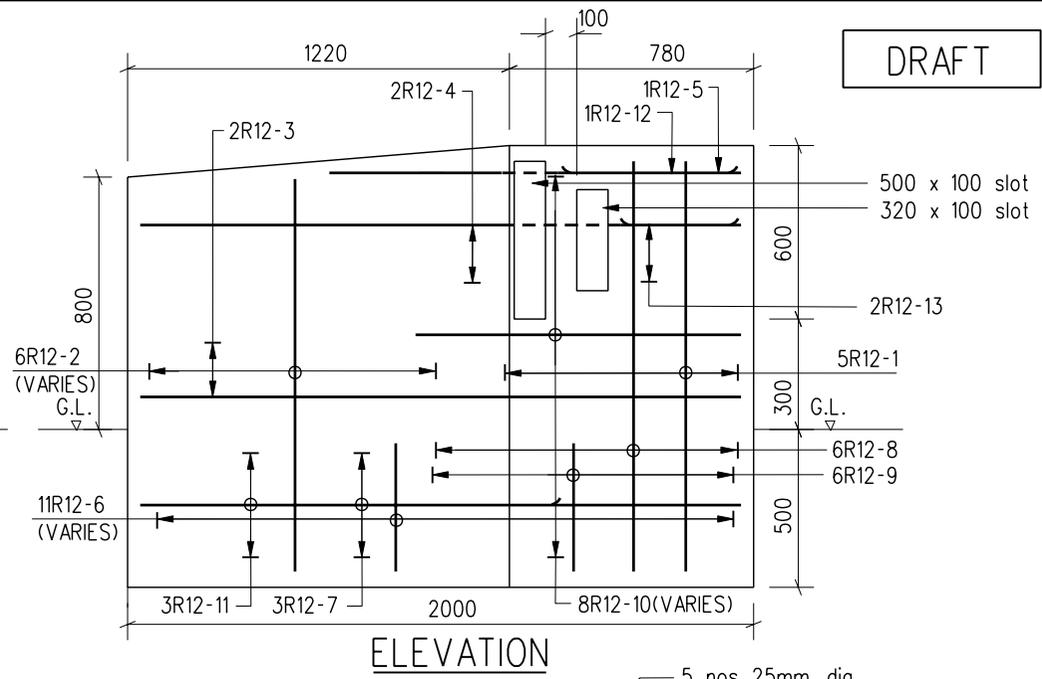
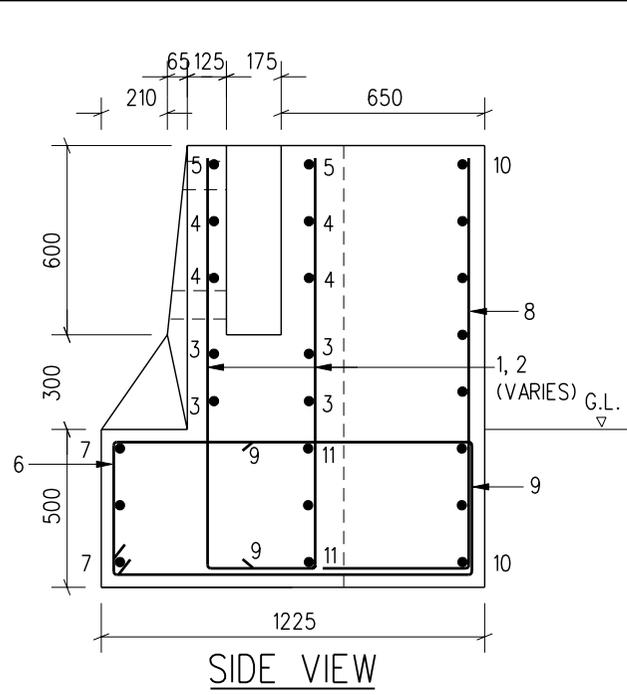
title

REINFORCEMENT DETAILS OF CONCRETE CONNECTOR
(SHEET 1 OF 4)

scale Not to Scale

drawing no. TB-07(R1)

DRAFT



Notes:

1. Dimensions are in millimetres.
2. This drawing shall be read in conjunction to drg. no. TB-07.
3. All concrete to be grade 30/20.
4. 40 cover to reinforcement.
5. Concrete surface shall be class F5 for formed finishes and class U5 for unformed finishes.

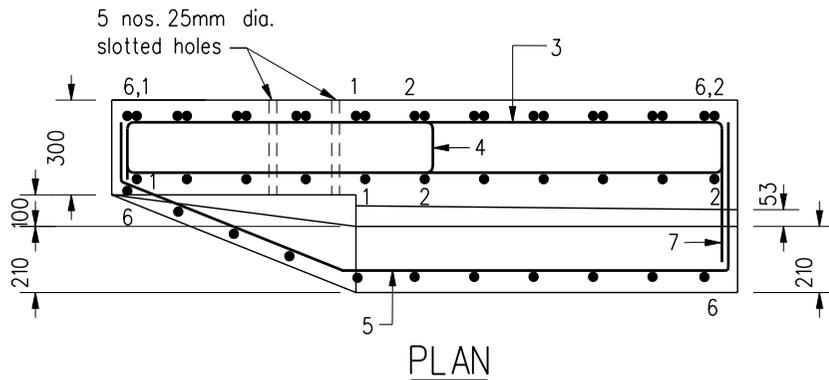
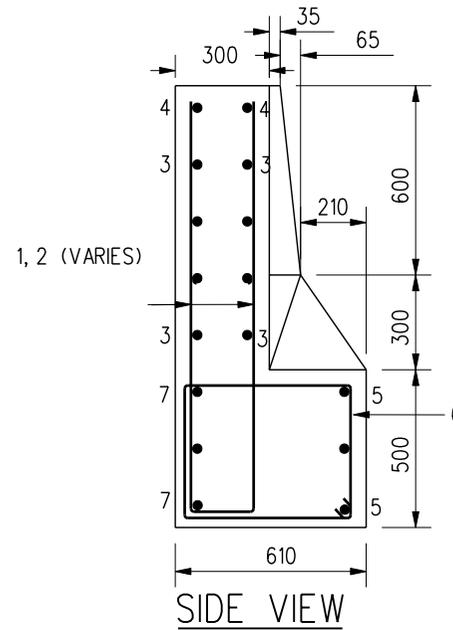
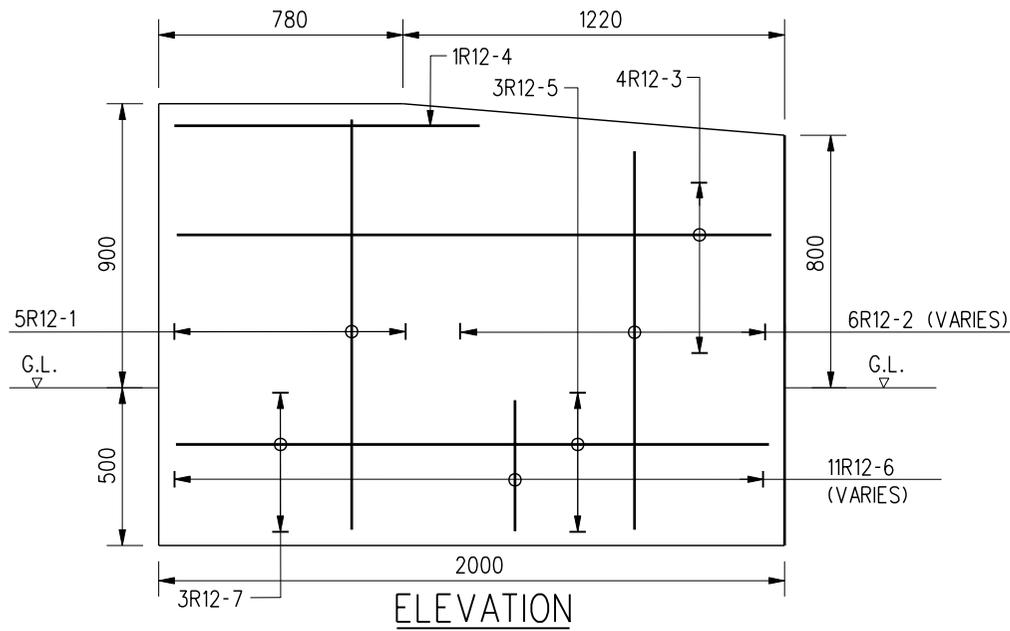
(FOR DOUBLE THRIE-BEAM BARRIER)

title

REINFORCEMENT DETAILS OF CONCRETE CONNECTOR
(SHEET 2 OF 4)

scale Not to Scale

drawing no. TB-07(R2)



Notes:

1. Dimensions are in millimetres.
2. This drawing shall be read in conjunction to drg. no. TB-08.
3. All concrete to be grade 30/20.
4. 40 cover to reinforcement.
5. Concrete surface shall be class F5 for formed finishes and class U5 for unformed finishes.

(FOR SINGLE THRIE-BEAM BARRIER)

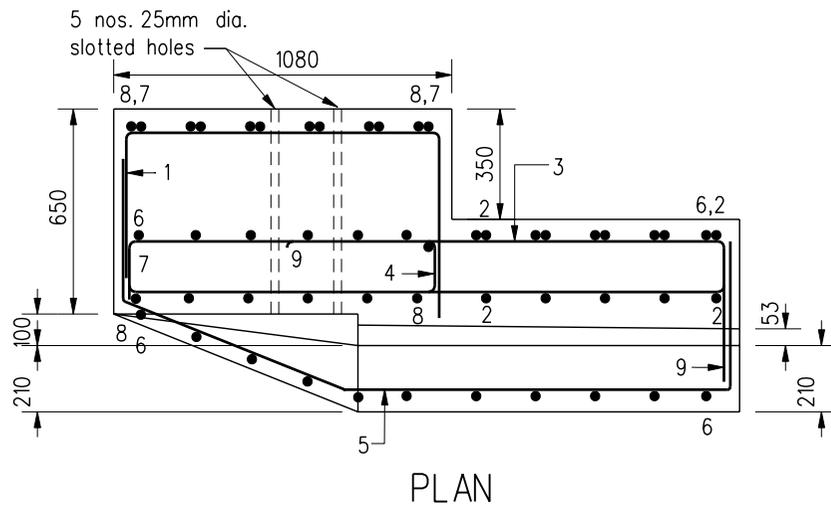
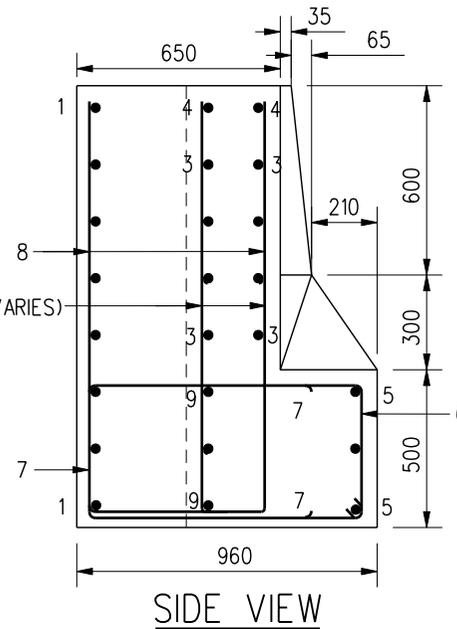
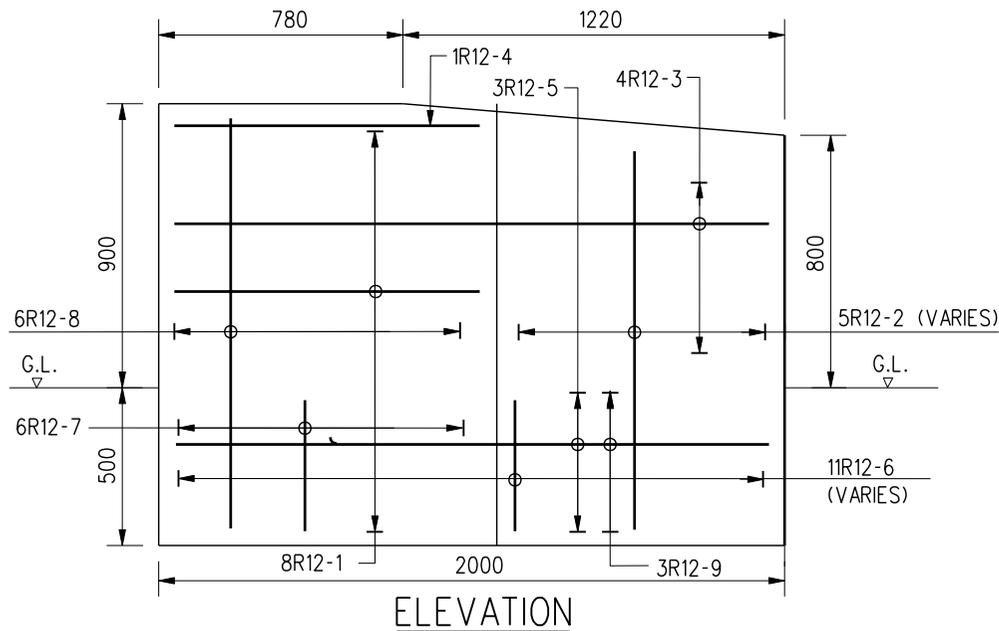
title

REINFORCEMENT DETAILS OF CONCRETE CONNECTOR
(SHEET 3 OF 4)

scale Not to Scale

drawing no. TB-08(R1)

DRAFT



Notes:

1. Dimensions are in millimetres.
2. This drawing shall be read in conjunction to drg. no. TB-08.
3. All concrete to be grade 30/20.
4. 40 cover to reinforcement.
5. Concrete surface shall be class F5 for formed finishes and class U5 for unformed finishes.

(FOR DOUBLE THRIE-BEAM BARRIER)

title

REINFORCEMENT DETAILS OF CONCRETE CONNECTOR
(SHEET 4 OF 4)

scale

Not to Scale

drawing no.

TB-08(R2)