Section 9

Traffic Control Devices and Road Safety Works

SECTION 9

TRAFFIC CONTROL DEVICES AND ROAD SAFETY WORKS

9.1 General

(i) Traffic control devices shall comprise of traffic signs, road markings, safety barriers, pedestrian railings, etc. Guidelines given in IRC:35, IRC:67 and Section 800 of the MOSRTH Specifications shall be followed in adopting appropriate road markings and traffic signs, unless otherwise specified in this Section.

(ii) The Concessionaire shall also follow the guidelines and suggestions stipulated in the MOSRTH "Manual for Safety in Road Design", while designing, constructing, operating and maintaining the two-lane highway.

9.2 Road Markings

All road markings shall conform to IRC:35. Road markings shall comprise of carriageway markings such as longitudinal markings on intersections, hazardous locations, parking, etc. and object markings such as object within the carriageway, adjacent to carriageway and marking on kerbs.

9.2.1 *Material*

(i) Hot applied thermoplastic paint with glass beads shall be used as carriageway marking materials.

(ii) Road marking paint conforming to IS:164 shall be used for object markings.

9.2.2 *Raised Pavement Markers (Cat's Eyes):*

The cat's eyes or road studs are used to form a semi-permanent marking and provide improved visibility during night time and wet-weather conditions. These shall be either reflex lens type or solid white beads. These shall be provided at hazardous locations and while approaching important intersections, to supplement the paint or thermoplastic line markings and road stretches passing through municipal areas or village settlements and habitations.

9.3 Road Signs

There are three types of road signs viz., mandatory/regulatory signs, cautionary/ warning signs, and informatory signs. Locations of signs shall conform to IRC:67 and Section 800 of MOSRTH Specifications.

9.3.1 *Sheeting*

The retro-reflective sheeting shall be used on the signs. The sheeting shall be weather-resistant and show colourfastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed laboratory by the manufacturer of the sheeting and shall be provided for review and comments, if any, of the Independent Engineer. The reflective sheeting shall be of High Intensity Grade with encapsulated lens or with micro prismatic retro-reflective element material as specified by the Government. The retro-reflective surface after

cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM Standard D 4956-04) as indicated in Tables 9.1 and 9.2.

9.3.2 *Messages/Borders*

The messages (legends, letters, numerals etc.) and borders shall either be screen-printed or of cut-outs. Screen-printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturers.

For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50% of the values of corresponding colour in Tables 9.1 and 9.2.

Table 9.1: Acceptable Minimum Coefficient of Retro-Reflection for High Intensity Grade Sheeting (Encapsulated Lens Type) (Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White[A]	Yellow[A]	Green[A]	Red[A]	Blue[A]
0.1°[B]	-4°	300	200	54	54	24
0.1°[B]	+30°	180	120	32	32	14
0.2°	-4°	250	170	45	45	20
0.2°	+30°	150	100	25	25	11
0.5°	-4°	95	62	15	15	7.5
0.5°	+30°	65	45	10	10	5.0

[A] *Minimum Coefficient of Retro-reflection (R_A) ($cd\text{-}lx^{-1}m^{-2}$)*

[B] *Value for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.*

Table 9.2: Acceptable Minimum Coefficient of Retro-Reflection for High Intensity Micro-Prismatic Grade Sheeting (Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White[A]	Yellow[A]	Green[A]	Red[A]	Blue[A]	Fluorescent Yellow-Green[A]	Fluorescent Yellow[A]	Fluorescent Orange[A]
0.1°[B]	-4°	500	380	70	90	42	400	300	150
0.1°[B]	+30°	240	175	32	42	20	185	140	70
0.2°	-4°	360	270	50	65	30	290	220	105
0.2°	+30°	170	135	25	30	14	135	100	50
0.5°	-4°	150	110	21	27	13	120	90	45
0.5°	+30°	72	54	10	13	6	55	40	22

[A] *Minimum Coefficient of Retro-reflection (R_A) ($cd\text{-}lx^{-1}m^{-2}$)*

[B] *Value for 0.1 observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.*

Cut out messages and borders, wherever used, shall be made out of retro-reflective sheeting (as per para 9.3.1), except those in black, which shall be non-reflective as specified by the manufacturer. The cutouts shall be bonded properly with the base sheeting in the manner specified by the manufacturer.

9.3.3 *Colour Scheme*

(i) Unless specified otherwise, the general colour scheme shall be in accordance with IRC:67, the colours shall be as stipulated in IS:5 "Colour for Ready Mixed Paints".

(ii) The colours shall be durable and uniform when seen in daylight or under normal headlights at night.

(iii) Direction, destination and plate identification signs shall have green background and white messages (legends, letters, numerals, etc.) and borders.

(iv) Colour scheme for facility information signs, other useful information signs and parking signs shall conform to the provisions contained in IRC:67. In respect of informatory signs, the messages/borders shall either be screen-printed or of cutouts, while for warning and regulatory signs, these shall be screen-printed.

(v) Clustering and proliferation of road signs shall be avoided for enhancing their effectiveness.

9.3.4 *Adhesives*

The sheeting shall either have a pressure-sensitive adhesive of the aggressive tack requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, or a tack free adhesive activated by heat applied in a heat-vacuum applicator, in a manner recommended by the sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The adhesive shall form a durable bond to smooth corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. In case of pressure sensitive adhesive sheeting, the sheeting shall be applied in accordance with the manufacturer's specifications. Sheeting with adhesives requiring use of solvents or other preparation for adhesive shall be applied strictly in accordance with the manufacturer's instructions.

9.3.5 *Installation*

The sign posts, their foundations and sign mountings shall be so constructed as to hold them in a proper and permanent position against the normal storm wind loads. Normally, signs with an area upto 0.9 sqm shall be mounted on a single post, and for greater area two or more supports shall be provided. Sign supports may be of mild steel (MS), reinforced concrete or Galvanized Iron (GI). Post end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant IRC/CPWD/PWD Specifications.

All components of signs and supports, other than the reflective portion and GI posts shall be thoroughly descaled, cleaned, primed and painted with two coats of epoxy paint. Any part of MS post below ground shall be painted with three coats of red lead paint.

The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size in the case of reinforced

concrete or GI posts. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

Important informatory signs such as approaching important locations, like Toll Plaza, major town shall be mounted on gantries, in the form of overhead signs.

9.3.6 *Warranty and Durability*

The Concessionaire shall obtain from the manufacturer a seven year warranty for satisfactory field performance including stipulated retro-reflectance of the retro-reflective sheeting of high intensity grade and submit the same to the Independent Engineer for review and comments, if any.

9.4. Roadside Safety Barriers

There are two types of safety barriers viz., longitudinal roadside safety barriers and median safety barriers.

9.4.1 *Warrants*

The longitudinal roadside barriers are basically meant to shield two types of roadside hazards i.e. embankments and roadside obstacles and also for preventing the vehicles veering off the sharp curves. The warrants for a fill section in terms of the height and slope needing protection with roadside barriers are shown in Fig.9.1. The barrier is not warranted for embankment having a fill slope of 3: 1 or flatter. The warrants for roadside objects are mainly dependent upon the type of obstacle and the probability of their being hit. A barrier shall be installed only if the result of vehicle striking the barrier is likely to be less severe than the severity of accident resulting from the vehicle impacting the unshielded obstacle. Some of the commonly encountered roadside obstacles are bridge piers, abutments and railing ends, roadside rock mass, culverts, pipes and headwalls, cut slopes, retaining walls, lighting supports, traffic signs and signal supports, trees and utility poles.

9.4.2 *Types of Roadside Safety Barriers*

There are broadly three types of longitudinal roadside safety barriers:

(a) Flexible type (like wire-rope fencing)

(b) Semi Rigid type, like

(i) "W' beam type steel barriers

(ii) Thrie beam type steel barriers

These steel barriers are of strong post type and usually remain functional after moderate collisions, thereby eliminating the need for immediate repair.

(c) Rigid type (like concrete crash barriers)

9.4.3 *Roadside Steel Barriers*

(i) Design Aspects: The "W" beam type safety barrier consists of a steel post and 3 mm thick "W" beam rail element which is spaced away from the posts. The spacer minimizes vehicular snagging and reduces the likelihood of a vehicle vaulting over the barrier. The steel posts and the blocking out spacer shall both be channel section of 75 mm x 150 mm size and 5mm thick. The rail shall be 700 mm above ground level and posts shall be spaced 2 m center to center. Typical details are shown in Fig. 9.2.

The thrie beam safety barrier shall have posts and spacers similar to the ones mentioned above for "W" beam type. The rail shall be placed 850 mm above

the ground level. This barrier has higher initial cost than the "W" beam type but is less prone to damages due to vehicle collisions especially for shallow angle impacts. Typical details of thrie beam barrier are shown in Fig. 9.3.

The "W" beam, the thrie beam, the posts spacers and fasteners for steel barriers shall be galvanized by hot dip process.

(ii) End treatment for steel barrier: An untreated end of the roadside barrier can be hazardous, if hit, because the barrier beam can penetrate the passenger compartment and cause the impact vehicle to stop abruptly. End treatments should therefore form an integral part of safety barriers. End treatment should not spear vault or roll a vehicle for head-on or angled impacts. The two end treatments recommended for steel barriers are "Turned down guardrail and Anchored in back slope".

Turned down guardrails have the "W" or thrie sections, reduced from full height to ground level, with a gentle slope over a distance of 8 to 9 m. The turned down rail is intended to collapse on impact, allowing the vehicle to pass over it without becoming airborne or unstable. In order to locate the barrier terminal away from the travelled way and to minimize driver's reaction to a hazard near the road, by gradually introducing a parallel barrier installation or to transition a roadside barrier nearer the roadway, such as a bridge parapet or a railing, the turned down rail should be flared away from the roadway. Suggested flare rates depend upon the design speed and the type of barrier (Table 9.3).

Table 9.3 : Flare Rates

Design speed in km per hour	Flare Rates	
	Rigid barriers	Semi-rigid barriers
100	17:1	13:1
80	14:1	11:1
65	11:1	9:1
50	8:1	7:1
40	8:1	7:1
30	8:1	7:1

The posts in the end treatment should have the same cross sections as provided in the main barrier.

At road cross-sections in cutting or if the road transitions from cut to fill, the safety barriers can be anchored in back slopes. The back slope covering the anchored portion of the barrier should be graded flat with side slopes preferably not steeper than 10:1. The anchored portion should develop a tensile strength in the rail element to prevent the rail from pulling out of the anchorage. The barrier can also be anchored in an earth berm specially constructed for this purpose, provided the new berm itself is not a hazard to the traffic. The earth berm should be made impervious to erosion.

(iii) Placement: Placement recommendations determine the exact layout of the barrier and should be made keeping in view the lateral offset of the barrier and flare rate. The final layout shall be a site-specific combination of these factors. The barriers should be as far away from the traffic as possible and

should preferably have uniform clearance between the traffic and the hazard.

As far as possible, the safety barrier should be placed beyond 2.5 m of the travelled way. For long and continuous stretches, this offset is not critical. The distance between the barrier and the hazard should not be less than the deflection of the barrier by an impact of a full sized vehicle. In case of embankments, a minimum distance of 600 mm should be maintained between the barrier and the start of embankment slope of a hazard to prevent the wheels from dropping over the edge. Typical details are shown in Fig. 9.4.

Flatter flare rates may be used, particularly where extensive grading would be required to ensure a flat approach from the travelled way, subject to the availability of right of way.

9.4.4 *Roadside Concrete Barriers*

(i) Design Aspects: Roadside concrete safety barriers are rigid barriers having a sloped front face and a vertical back face. The recommended designs of the cast in-situ and pre-cast barriers are shown in Figs.9.5 and 9.6 respectively. Based on evaluation of vehicle direction, sight distance, structural stability and the psychological effect of barrier height on driver reaction, the most desirable height of the median barrier is 800 mm. Variations upto 50 mm in height of barrier can be made in the total height of the barrier to meet the site requirements. It is, however, important to maintain the height of lower slope between 200 mm and 350 mm so as to reduce the chances of overturning of the vehicles.

The concrete barrier may be pre-cast in lengths up to 6 m, depending upon the feasibility of transport and lifting arrangements. Concrete grade for the barriers should not be leaner than M30. The minimum thickness of foundations shall be 25 mm cement concrete or hot mix asphalt placed at the base of barrier, to provide lateral restraint. Where more than 75 mm thick overlay on the road pavement is anticipated, the foundation step may be increased to 125 mm. However, longitudinal roadside concrete barrier should have elaborate footing design which is structurally safe, unless sufficient earth support is available.

(ii) End Treatment: Safety barrier shall be provided with an end treatment, which shall be obtained by tapering the height of terminating end of the median barrier within a length of 8 m to 9 m.

(iii) Placement: Placement recommendations for roadside steel barriers, given in para 9.4.3 above, are applicable to concrete barriers as well.

9.4.5 *General*

(i) Raised curbs or drains shall not be provided between the travelled way and the barriers. These destabilize the vehicle balance and disturb its equilibrium before it strikes the barrier, thus defeating the essential purpose of safety and redirection of the impacting vehicle.

(ii) In rural situations, both the roadside and the median barriers shall preferably be steel barriers. Concrete barriers shall be preferred in urban situations.

9.5 Safety during Construction

Widening of an existing road requires special attention to traffic diversion, traffic management and road safety. A proper Traffic Management Plan during construction shall be formulated by the Concessionaire as per guidelines given in IRC:SP:55 and submitted to the Independent Engineer for review and comments, if any. The Traffic Management Plan during construction shall be put in place before the start of any construction activity.

The execution of work shall be so planned that the inconvenience to the traffic is minimal. The temporary diversion, where constructed, shall conform to the following minimum standards:

(i) Width of diversion road shall be equal to the width of the existing carriageway but not less than 5.5 m.

(ii) The crust composition shall be of 150 mm GSB + 150 mm WBM + 20 mm Mixed Seal Surfacing.

9.6 Design Report

The Concessionaire shall submit proposals for traffic control devices and road safety works together with drawings and details to the Independent Engineer for review and comments, if any. The proposals shall include:

(i) Details covering type, location, material specifications, installation details and the requisite warranties for satisfactory field performance (as applicable) in respect of road signs, road markings and roadside safety barriers;

(ii) Traffic Management Plan during construction in accordance with the requirement specified in para 9.5 above.

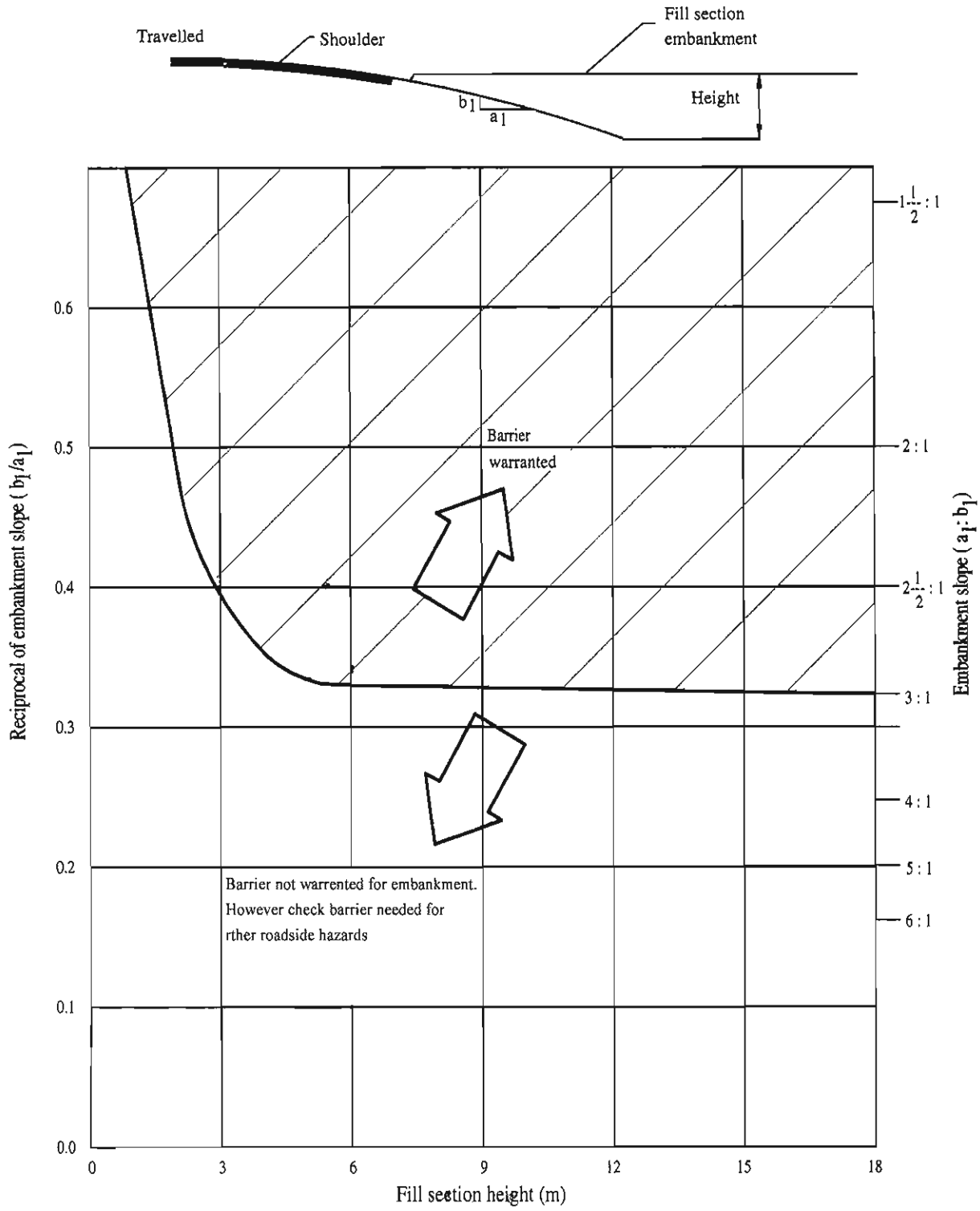
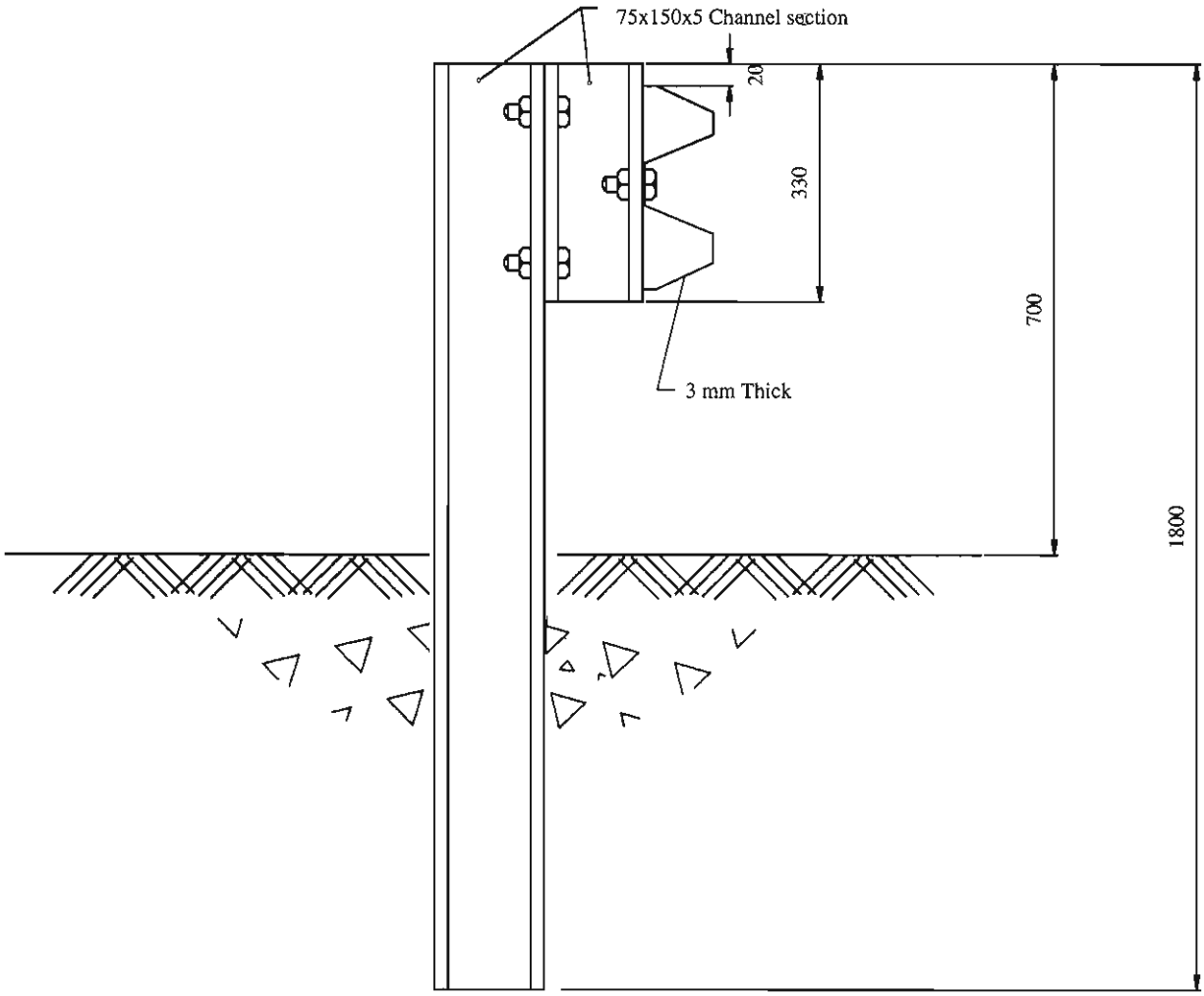
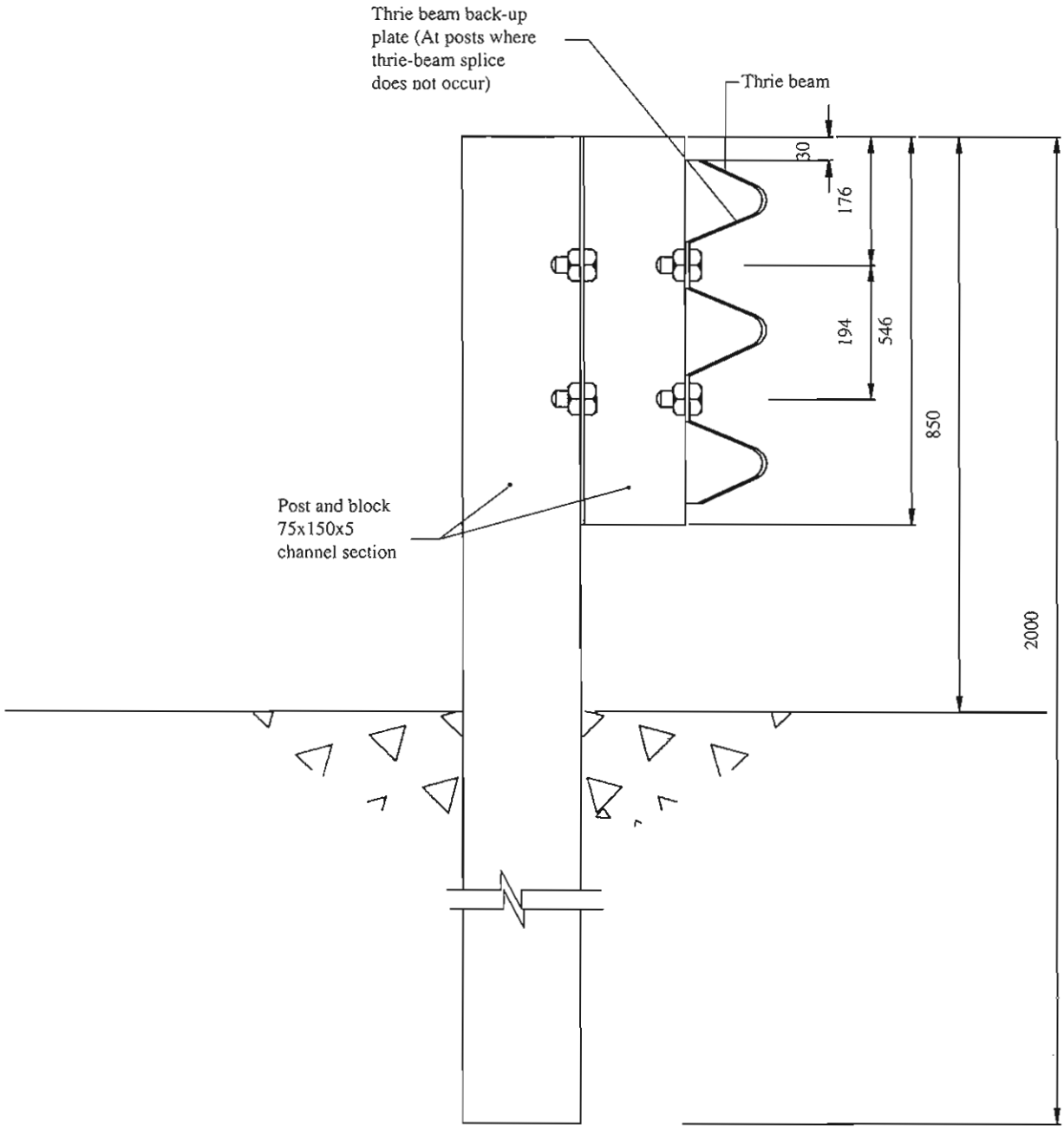


Fig. 9.1 : Warrants for roadside barriers on embankments



Note:
All dimensions are in mm.

Fig. 9.2 : Typical details of "W" beam section



Note:
All dimensions are in mm.

Fig. 9.3 : Typical details of thrie beam section

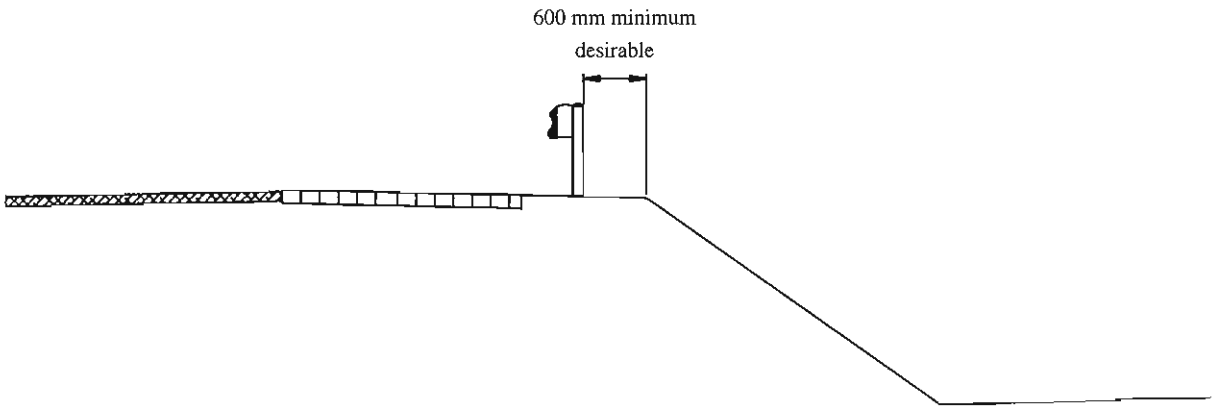
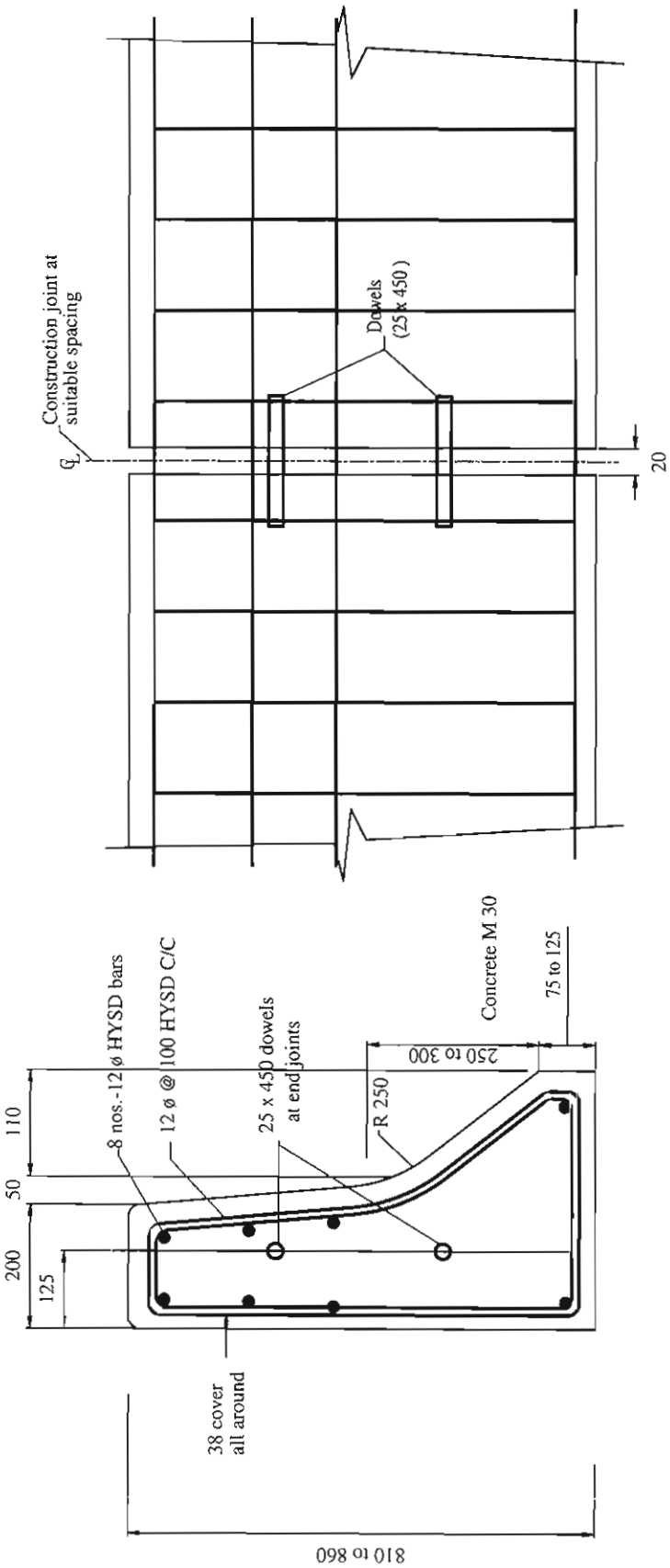


Fig. 9.4 : Recommended barrier placement



Note:
1. HYSD-High yield strength deformed reinforcement.
2. All dimensions are in mm.

Fig. 9.5 : Side barrier cast-in-situ design

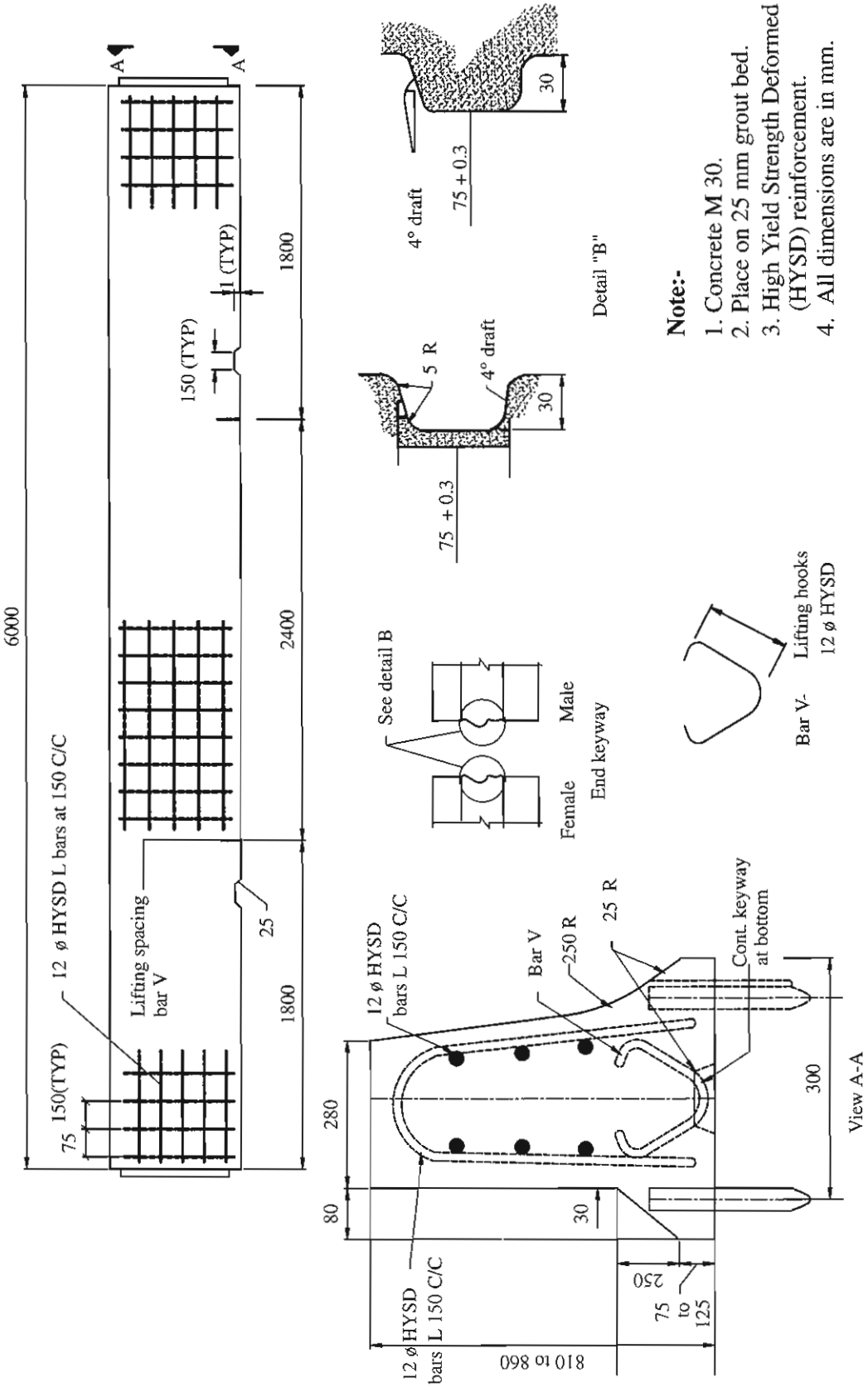


Fig. 9.6 : Side barrier precast design