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No.RW/NH/33022/1/94-DO III *Dated, the 24th June, 1994*

To

Chief Engineers PWDs of all States/UTs; Director General (Works), Central Public Works Department; Director General Border Roads; National Highway Authority

Subject: Installation of Safety Barriers along the Indian road network

Available statistics on road accidents indicate that user behaviour is an important contributory factor in a majority of accidents. None-the-less proper road design can play a useful role towards in-building safety and reducing driver error thereby reducing the risk of accidents. The need for adoption of safety- conscious highway design process has therefore gained importance. Many road accidents involve run-off-the road vehicles colliding with hazardous obstacles, rolling down high embankments, veering off the carriageway on sharp curves or crossing over the median and colliding with an oncoming vehicle. Safety barriers are effective means to reduce the risk of and to mitigate the severity of such accidents. As such these barriers constitute an important safety furniture.

2. Keeping in view the contributory role played by the safety barriers in enhancing road safety at the warranted locations, guidelines for their installation have been prepared and are annexed for adoption in safer road design. The guidelines cover the warrants for provision of the safety barriers, their types, design aspects, dimensional and layout details and placement recommendations and include both the roadside and the median barriers.

3. It may be noted that adoption of semi-rigid steel barriers and rigid concrete barriers has been recommended depending upon the locational and site specific requirements. While steel barriers may be provided where normal shoulder and median widths are generally available, concrete barriers may be considered along narrow medians and/or shoulders. Considering the cost economics and the indigenous availability aspect, adoption of "W" section steel barriers should be preferred.

4. For accelerating the installation of safety barriers at need-based locations, it is suggested that a comprehensive field survey of the National Highway sections falling within your State/UT may be organised early. Based thereon, all the accident-prone and substandard sections needing barrier protection as per the warrants stipulated in the guidelines should be identified and proposals for provision of safety barriers to shield hazardous situations should be framed. Keeping in view the budgetary provisions, prioritisation of the safety barriers may be made with reference to safety requirements, economic and environmental factors.

5. Since the installation of steel barriers on the country's highway system is in an introductory stage, it is necessary that these meet the safety and structural requirements. It should, therefore, be ensured that the manufacturers of steel barriers possess adequate and proven technical know-how in terms of design, specifications and standards etc., which should be duly supported by necessary documentation. In addition the manufacturers/suppliers of the barriers should be asked to submit, alongwith their proposals, detailed design calculations for the structural components and foundations of the barriers. The proposed structures should meet the requirements of safety and structural adequacy as laid down in internationally accepted standards. The manufacturers/ suppliers should give details of their experience in supplying and installing such barriers. They should also be asked to undertake complete responsibility for safety, structural adequacy and satisfactory field performance of the barrier system.

6. Since the guidelines for installation of safety barriers on Indian roads have been framed for the first time, these may need revision in the light of the experience gained. In the meantime, suggestions for improvement of these guidelines will be appreciated.

Annexure

Enclosure to Ministry's Circular No.RW/NH-33022/1/94- DO III Dated 24th June, 1994

GUIDELINES FOR INSTALLATION OF TRAFFIC SAFETY BARRIERS

1. Introduction

1.1. Many road accidents involve run-off-the-road vehicles colliding with hazardous obstacles such as poles, trees, bridge supports, simply rolling down a high embankment or vehicles veering off the traveled way on sharp curves. Additionally, a vehicle crossing across the median of a dual carriageway runs the risk of collision with an oncoming vehicle. Incidence of accidents due to such potential hazards can be greatly mitigated by the use of safety barriers.

1.2. The main purpose of these guidelines is to bring out the design aspects of safety barriers and establish the warrants for their provision, to disseminate information on various types of safety barriers available alongwith their strength and safety characteristics, dimensional aspects and layout details for the barriers.

2. Requirements of a safety barrier

2.1. The basic criteria for determining the need for a safety barrier is that it should absorb the impact energy and reduce the SEVERITY of accidents involving vehicles leaving the travelled way. Since a safety barrier is in itself a hazard to traffic it should be installed only if the severity of accidents due to striking the barrier, which is shielding the hazard, is lower than what it will be without the barrier. Decision for installing the safety barrier should be dictated by the safety requirements duly considering the social, environmental and economic factors.

2.2. Safety and structural requirements of a safety barrier are :-

(i) It should contain and redirect the vehicle, not allowing it to penetrate or vault over the barrier.

(ii) It should not cause sudden deceleration or spin of the vehicle.

(iii) The vehicle should remain upright during and after the impact and there should not be any loose elements which can penetrate the vehicle.

(iv) After impact, the final stopping position of the errant vehicle should intrude only minimally into the adjacent traffic lanes.

(v) It should provide a good visual guide for the road users.

(vi) It should not deflect more than the space available for deflection.

2.3. The major factor to be considered for the selection of a particular barrier system is the matching dynamic lateral deflection characteristics of the system to the space available at site (including space for end treatment) so as to mitigate the severity of impact. Other factors needing consideration are initial cost, future maintenance costs and aesthetics. However, enhancement of vehicular safety and crashworthiness of the system should be given more weightage as compared to aesthetics.

3. Types of safety barriers

3.1. The safety barriers can be classified as flexible, semi-rigid, or rigid. The major difference between the various types is the amount of barrier deflection that takes place when the barrier is struck. The flexible system is the most yielding type and is more for containment than redirection of the vehicle and requires more lateral clearance from fixed objects due to deflection during impact. Semi-rigid barriers offer requisite resistance to control the deflection of longitudinal member to an acceptable limit and the errant vehicle is redirected along the travel path. The rigid system does not deflect on impact but causes the maximum severity of impact, amongst the three types. As the angle of impact increases this barrier becomes less forgiving. Installation of a rigid system should be considered where shallow impact angles are expected such as along narrow medians or shoulders which could be expected in urban situations. As the rigid system suffers little or no damage on impact, it requires the least maintenance efforts.

3.2. Safety barriers dealt in these guidelines are longitudinal roadside safety barriers, and median safety barriers. Steel barriers of semi-rigid type and rigid concrete barriers are described.

4. Roadside Safety Barriers

4.1. Warrants

4.1.1. 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 its height and slope, needing protection with roadside barriers are shown in Fig. 1. It may be noted that no barrier is 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 should 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. Judgement of the Engineer-in-Charge should be applied to arrive at the necessity of providing a barrier to shield obstacles which cannot be removed. 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 sign and signal supports, trees, and utility poles.

4.2. Types of Roadside Safety Barriers

4.2.1. Types of longitudinal roadside safety barriers which could be used are :-

(i) "W" beam type steel barrier

(ii) Thrie beam type steel barrier

(iii) Concrete barriers

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

4.3. Roadside Steel Barriers

4.3.1. Design Aspects

4.3.1.1. The "W" beam type safety barrier consists of a steel post and a 3 mm thick "W" beam rail element which is spaced away from the posts. The spacer minimises vehicular snagging and reduces the likelihood of a vehicle vaulting over the barrier. The steel post and the blocking out spacer shall both be channel section of 75 x 150 mm size 5 mm thick. The rail shall be 70 cm above the ground level and posts shall be spaced 2m center to center. Typical details are shown in Fig. 2.

4.3.1.2 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 at 85 cm above the ground level. This barrier has a higher initial cost than the "W" beam type but is less prone to damages by vehicle collisions especially for shallow angle impacts. Typical details of thrie beam barrier are shown in Fig. 3.

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

4.3.2. **End treatment for steel barrier**

4.3.2.1. 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. And 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 backslope".

4.3.2.2. Turned-down guardrails have the "W" or thrie section reduced from full height to ground level with a gentle slope over a distance of 8 to 9 meters. 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 minimise drivers' 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 depending upon the design speed and type of barrier are as follows:-

Design speed in km per hr	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

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

4.3.2.4. At road cross sections in cutting or if the road transitions from cut to fill, the safety barriers can be anchored in backslopes. The backslope 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.

4.3.3. **Placement Recommendations**

4.3.3.1. Placement recommendations determine the exact layout of the barrier and should be made by the design engineer 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.

4.3.3.2. As far as possible the safety barrier should be placed beyond 2.5m 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 60 cm should be maintained between the barrier and the start of embankment slope or a hazard to prevent the wheels from dropping over the edge. Typical details are shown in Fig. 4.

4.3.3.3. 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.

4.4. Roadside Concrete Barriers

4.4.1. Design Aspects

4.4.1.1. Concrete roadside safety barriers are rigid barriers having a sloped front face and a vertical back face. The recommended designs of the cast-in-situ and precast barrier are shown in Figs. 5 and 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 80 cm. 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 20cm and 35cm so as to reduce the chances of overturning of the vehicles.

4.4.1.2. The concrete barrier may be precast in lengths of upto 6m depending upon the feasibility of transport and lifting arrangements. Concrete grade for the barriers should be M-200. The minimum thickness of foundation may be 25mm thick 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.

4.4.2. End Treatment

4.4.2.1. 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.

4.4.3. Placement Recommendations

4.4.3.1. Placement recommendations for roadside steel barriers, mentioned in para 4.3.3. above, are applicable to concrete barriers as well.

5. Median Barriers

5.1. Head-on-collisions, especially on highways with narrow medians, caused by out-of-control vehicles jumping across the medians, are a major source of accidents. Fixed objects on medians also require shielding from the traffic flow. Provision of median safety barrier in such conditions is an important requirement.

5.2. Warrants

5.2.1. The requirement of a median barrier is a function of the width of the median and the traffic volume on the road. Fig.7 indicates the warrants for provision of median barriers in terms of the combination of median width and ADT in PCUs. At ADT less than 20000 PCUs and with medians wider than 9m, the probability of a vehicle crossing across the median is relatively low and median barriers in such cases are optional. Medians with width between 9 and 15m do not warrant a barrier unless there is an adverse history of median cross-overs.

5.2.2. Median barriers may be impractical where a road has a large number of closely spaced median openings since the barrier needs to be terminated with an end treatment at these points.

5.2.3. An evaluation of the number of median openings, accident history, alignment, sight distance, design speed, traffic volume and median width need to be made prior to taking a decision to install a median barrier.

5.2.4. Median barriers should also be provided to shield fixed objects in a narrow median. If necessary, median barriers should be flared to encompass a fixed object, which may be a lamp post, foundation of overhead signs, bridge pier etc.

5.3. Types of Median Barriers

5.3.1. Recommended types of median safety barriers are :-

(i) "W" beam type steel barrier (Strong post type)
(ii) Thrie beam type steel barrier (Strong post type)
(iii) Concrete barriers

5.4. Steel Median Barriers

5.4.1. Design Aspects

5.4.1.1. The "W" beam barrier shall be similar to the roadside barrier described in para 4.3 above except that the "W" beam shall be provided on both sides of the post with similar spacers. Typical details are indicated in Fig.8.

5.4.1.2. The thrie beam barrier shall be similar to the roadside barrier described in para 4.3 above except that the thrie beam shall be provided on both sides of the post with similar spacers. Typical details are shown in Fig.9.

5.4.2. End Treament

5.4.2.1. Steel median barriers shall be provided with a "Turned-down-guardrail" end treatment as described in para 4.3.2 above except that no flaring is to be provided.

5.4.3. Placement Recommendations

5.4.3.1. At locations, where the two adjacent carriageways are at the same level, the barrier shall be placed in the center of the median, duly taking into consideration, the drainage requirements. The placement of median barriers in cases where the two carriageways are at different levels is a function of the slopes between the two medians. Recommended placement for various combinations is indicated in Fig. 10. In case the median barriers need to be flared e.g. for the protection of supports to overhead signs, the flare rates mentioned in para 4.3.2.3 above shall be followed.

5.5. Concrete Median Barriers

5.5.1. Design Aspect

5.5.1.1. The design of cast-in-situ and precast median barriers is indicated in Figs. 11 and 12.

5.5.2.1. Median barrier shall be terminated sufficiently away from the median opening with the twin objectives of preventing impact by the turning traffic and providing adequate sight distance to the turning traffic. The terminating end of the median barrier shall be tapered in a length of 8 to 9 meters.

5.5.3. Placement Recommendations

5.5.3.1. Placement recommendations for steel median barriers mentioned in para 5.4.3 above apply to concrete median barriers also.

6. General

6.1. Raised curbs or drains should not be provided between the travelled way and the barriers. These destabilise 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.

6.2. In rural situations both the roadside and the median barriers should preferably be steel barriers. Concrete barriers should be preferred in urban situations.

6.3. A typical road cross section with barriers is shown in Fig. 13.

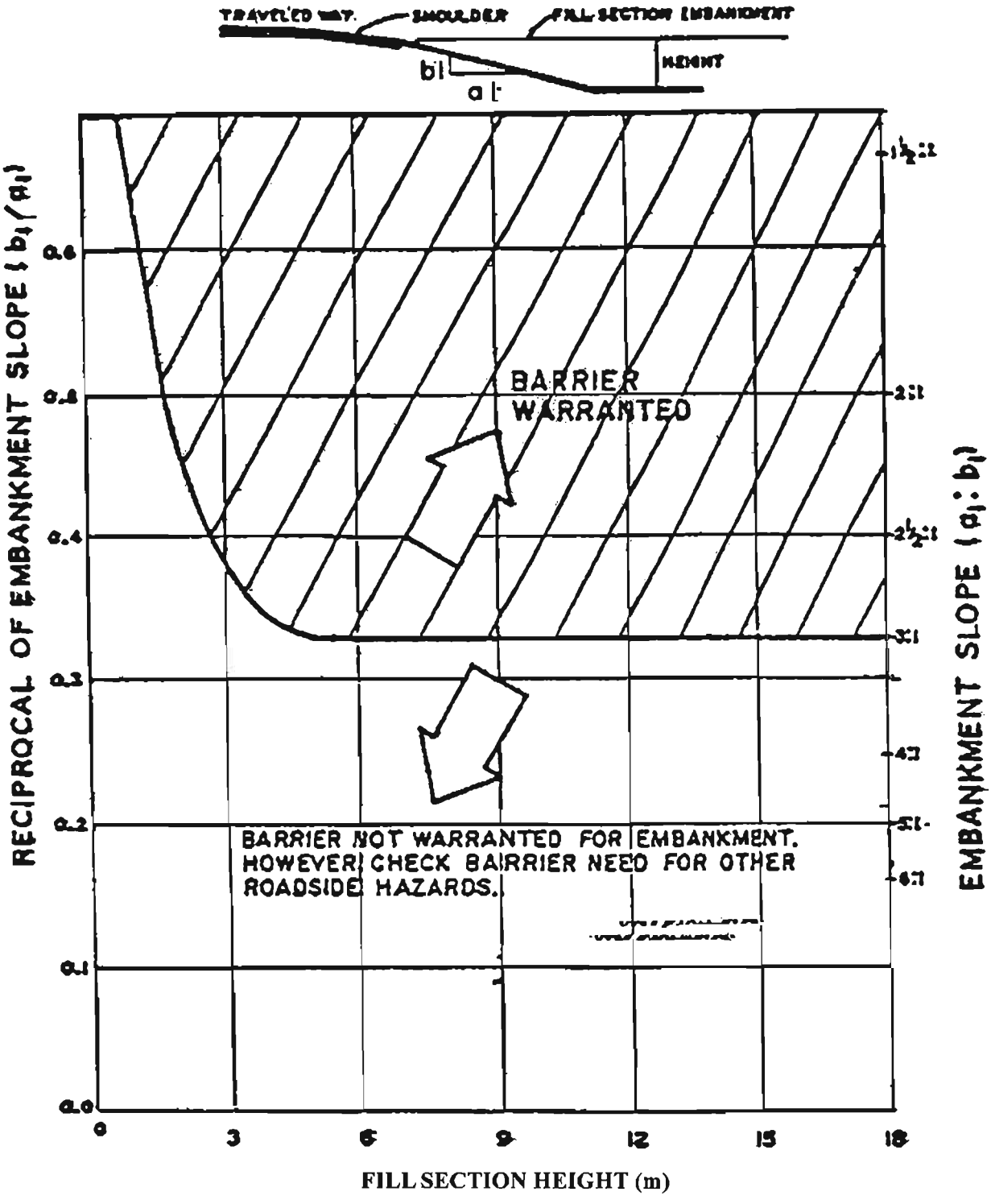


FIG. 1. WARRANTS FOR ROADSIDE BARRIERS ON EMBANKMENTS

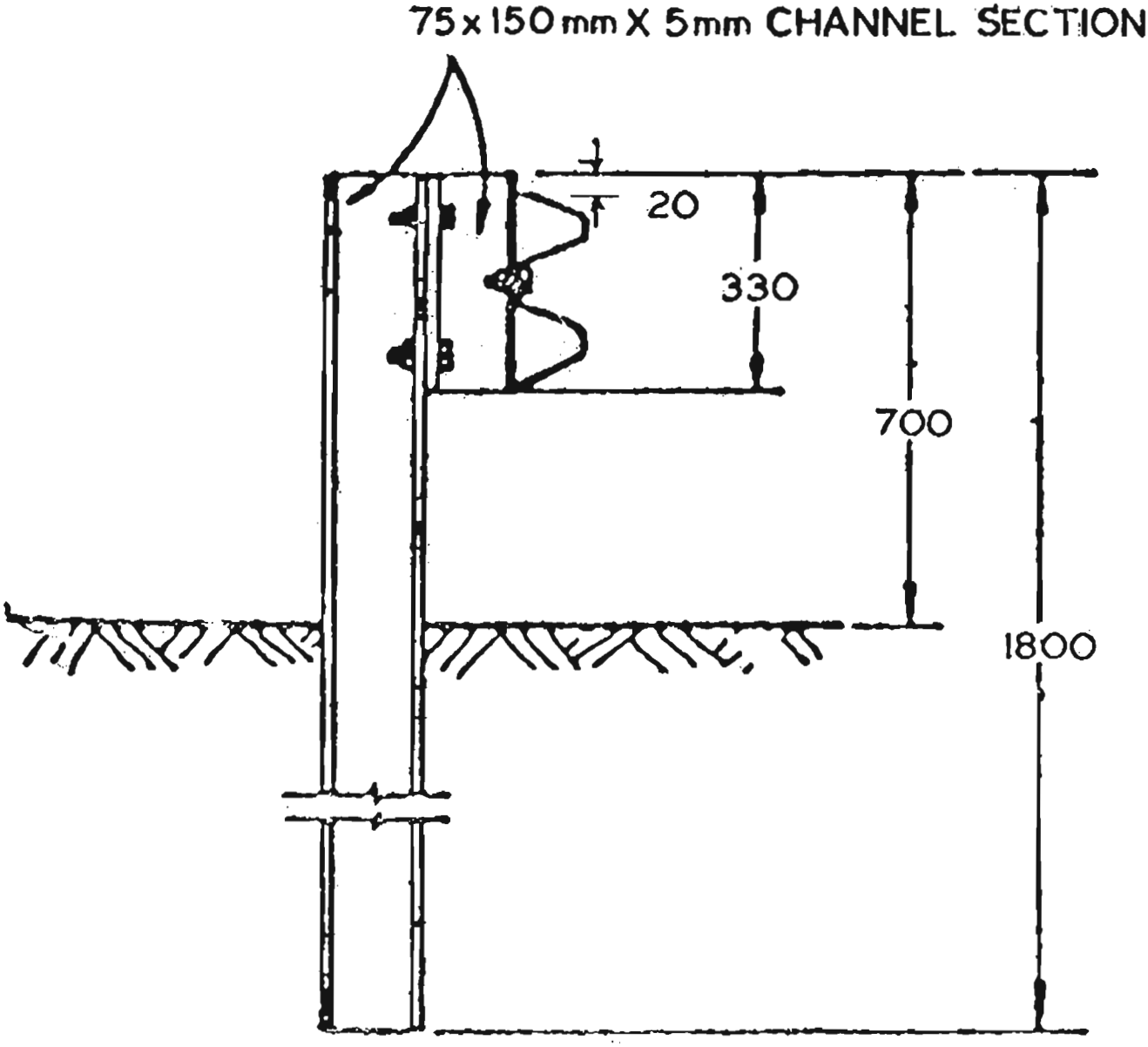


FIG. 2. TYPICAL DETAILS OF "W" BEAM SECTION

(ALL DIMENSIONS ARE IN mm)

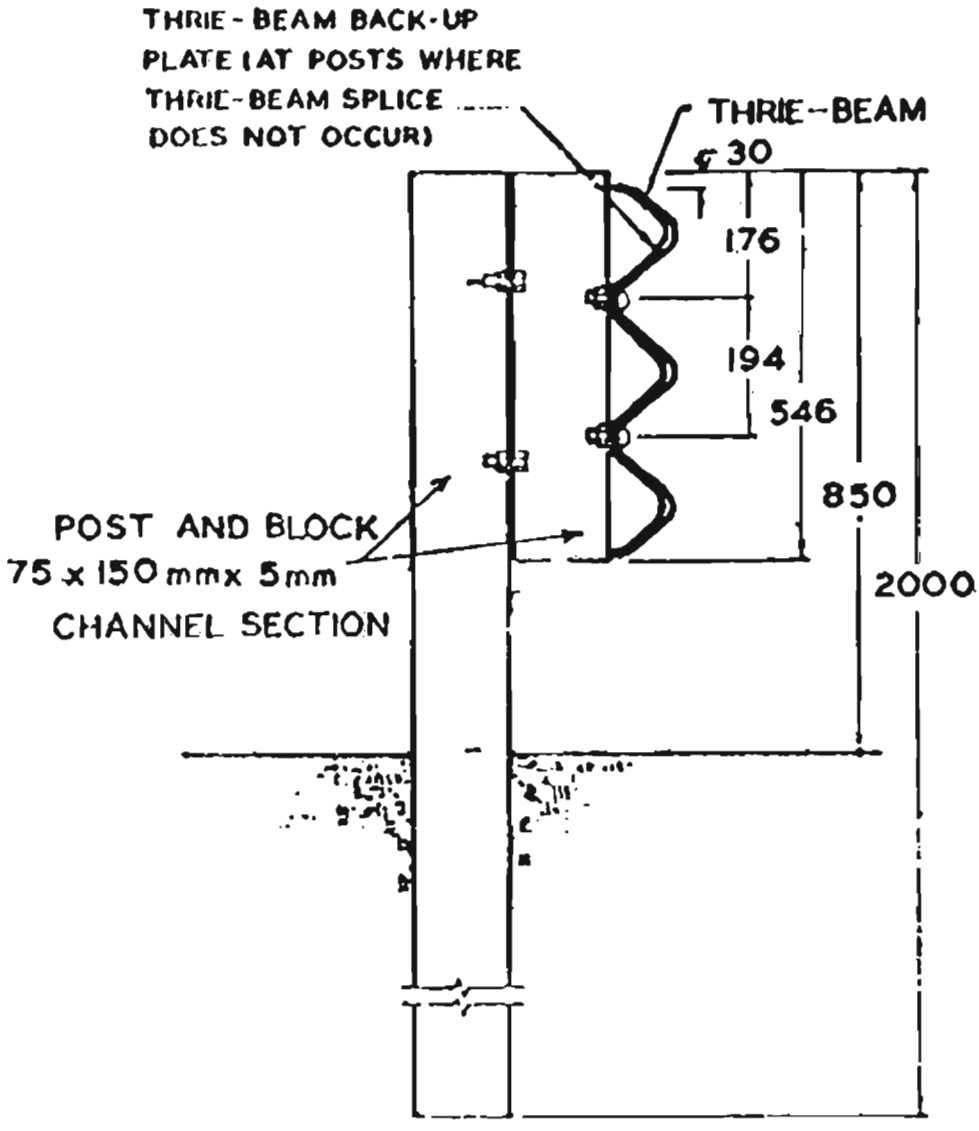


FIG. 3 TYPICAL DETAILS OF THRIE BEAM SECTION

(ALL DIMENSIONS ARE IN mm)

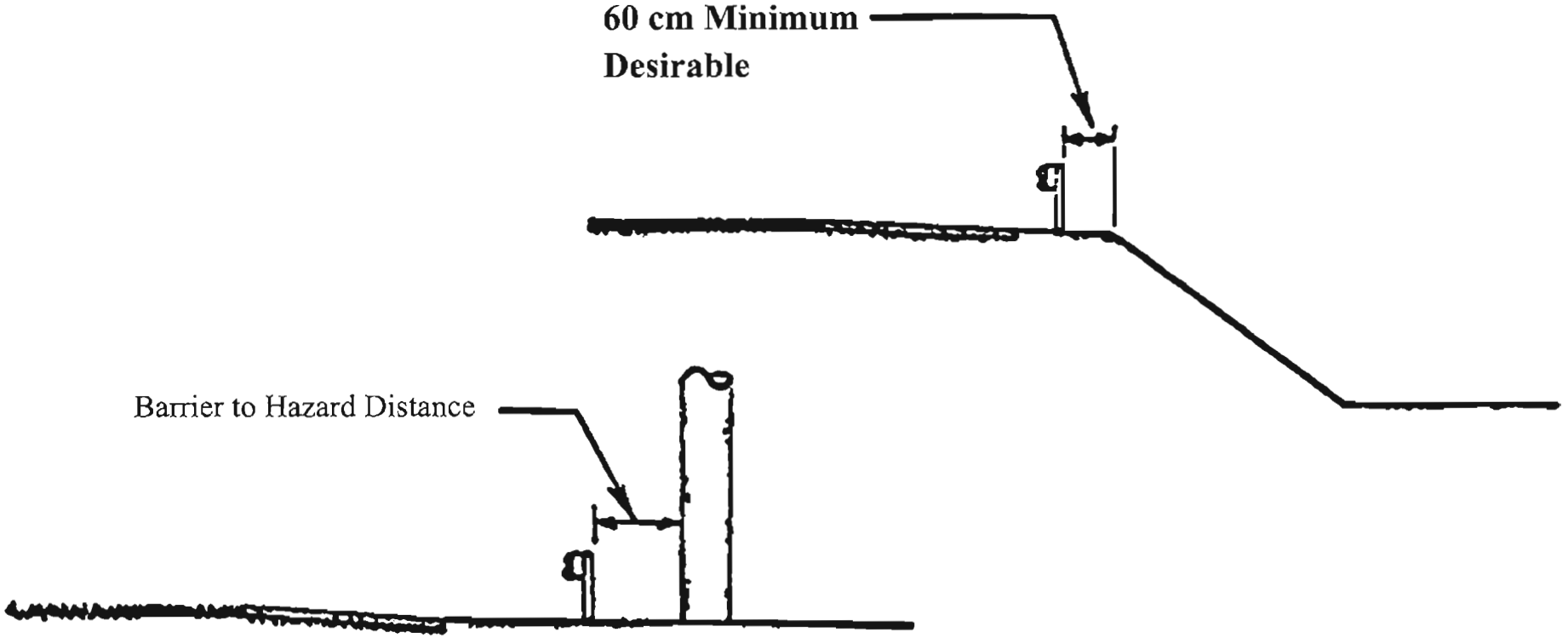
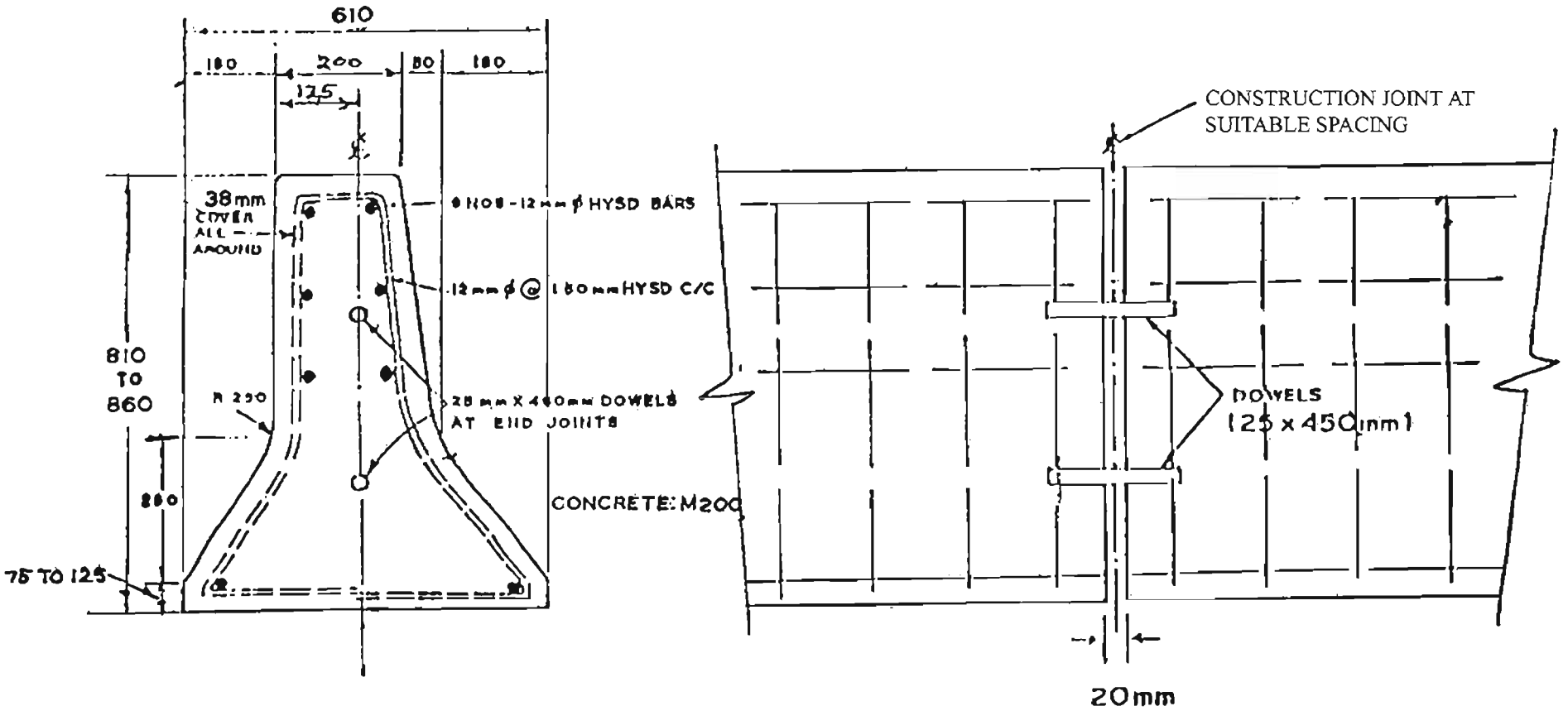


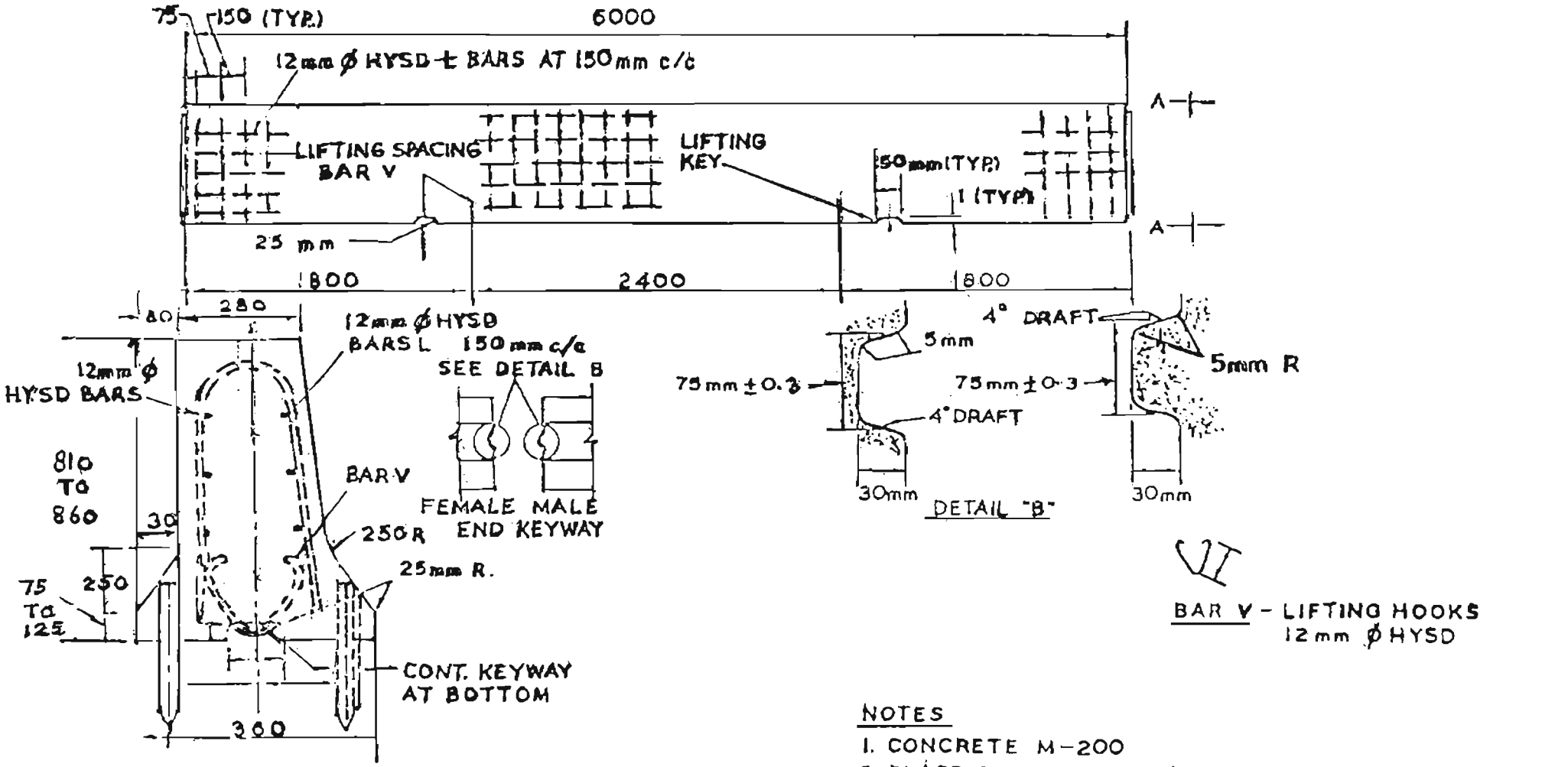
FIGURE 4. Recommended Barrier Placement



NOTE:- HYSD - HIGH YIELD STRENGTH DEFORMED REINFORCEMENT

FIG.5 ROADSIDE BARRIER CAST-IN-SITU DESIGN

(ALL DIMNSIONS ARE IN mm)



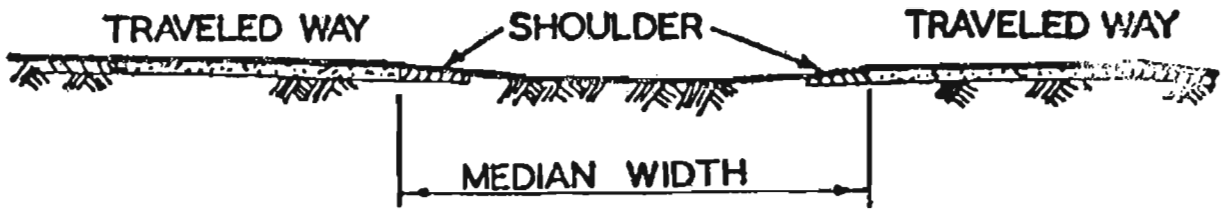
VIEW A-A

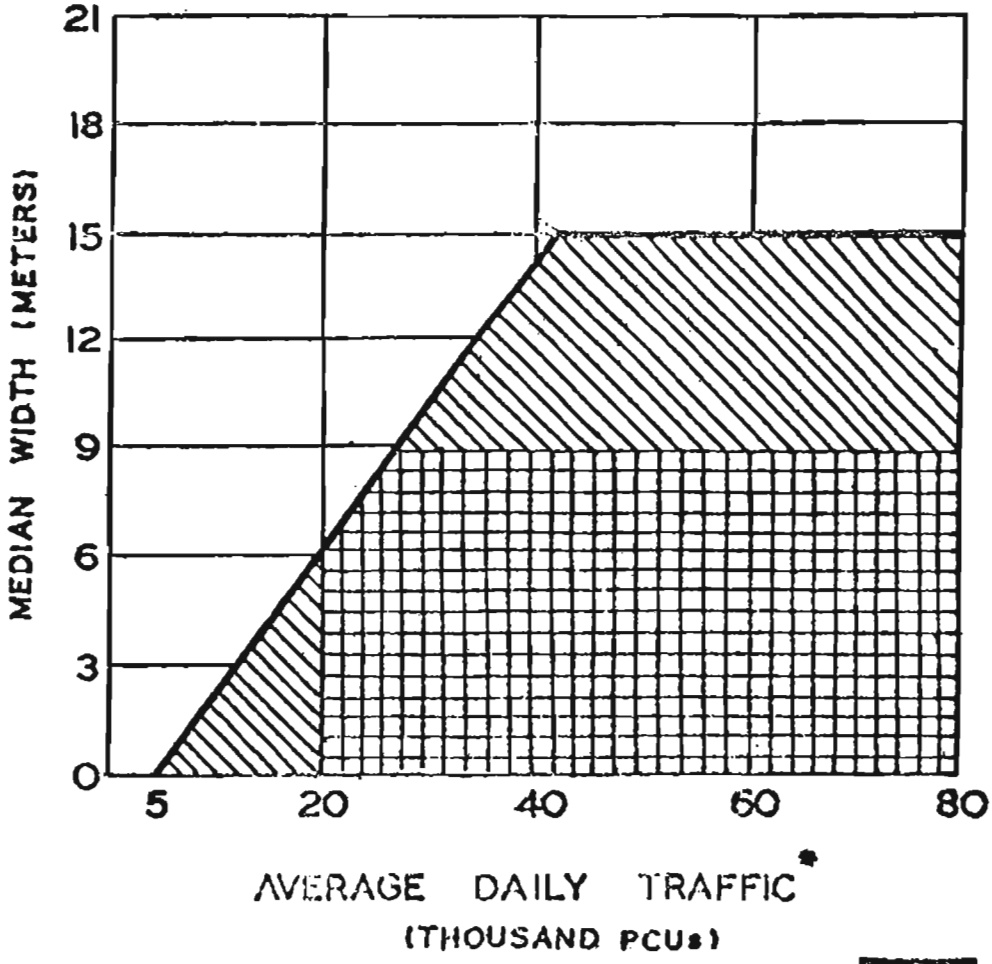
NOTES

1. CONCRETE M-200
2. PLACE ON 25mm GROUT BED
3. HYSD-HIGH YIELD STRENGTH DEFORMED REINFORCEMENT

FIG.6 ROADSIDE BARRIER PRECAST DESIGN

(ALL DIMENSIONS ARE IN mm)





* BASED ON A 5-YEAR PROJECTION

WARRANTED

OPTIONAL

FIG. 7 MEDIAN BARRIER WARRANTS

W-Beam (Strong Post)

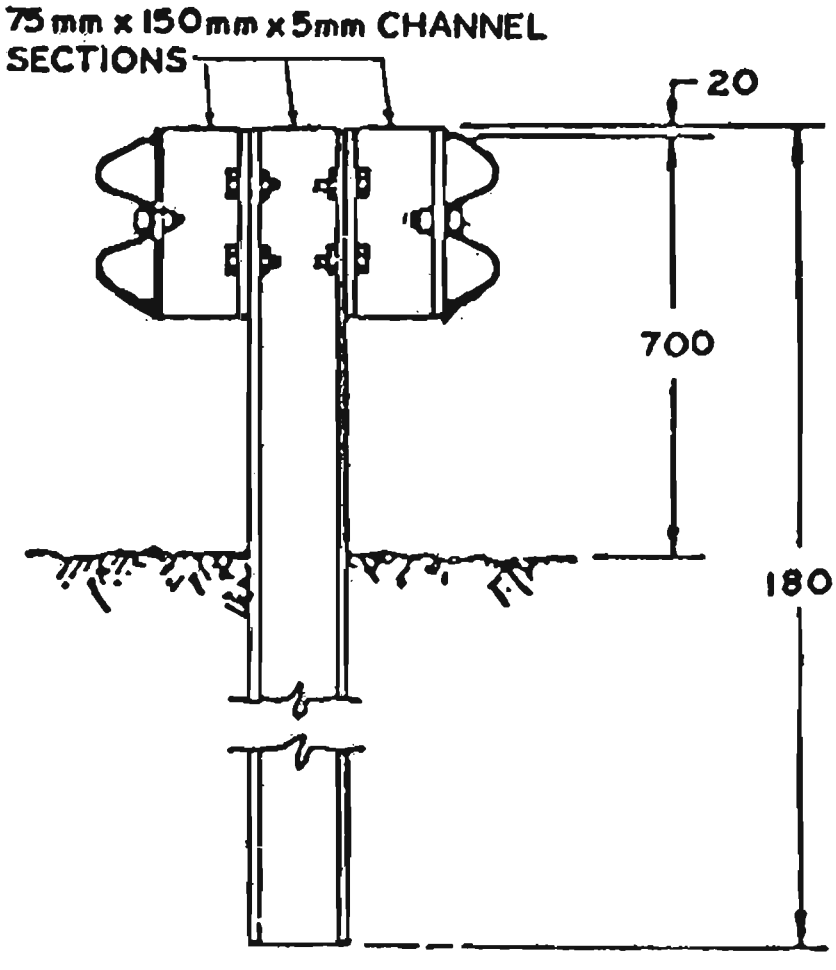


FIG. 8 TYPICAL DETAILS OF "W" BEAM MEDIAN BARRIER

(ALL DIMENSIONS ARE IN mm)

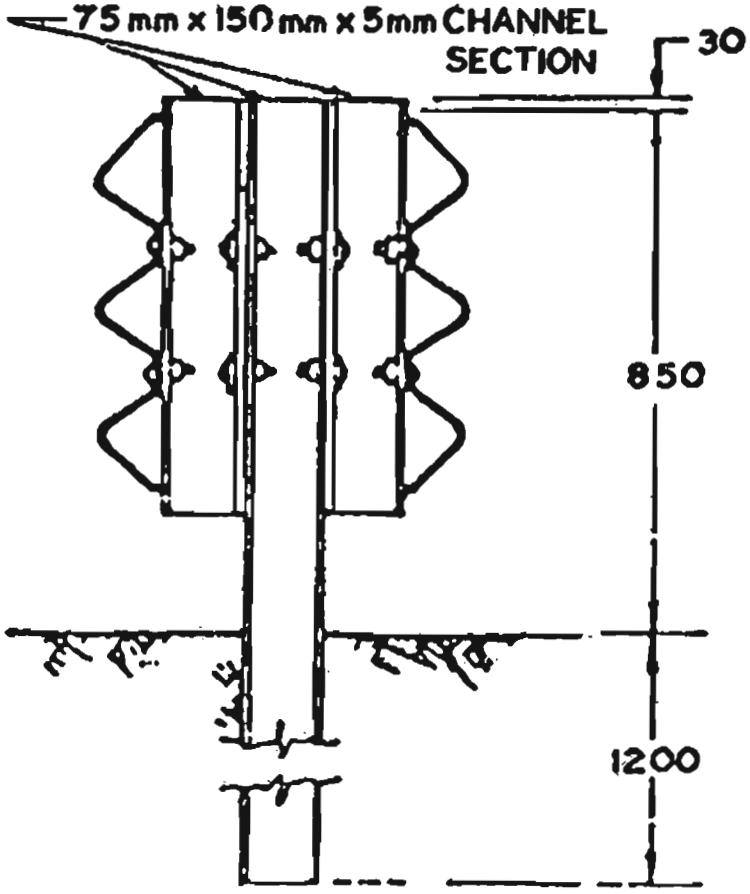


FIG. 9. TYPICAL DETAILS OF THRIE BEAM MEDIAN BARRIER

(ALL DIMENSIONS ARE IN mm)

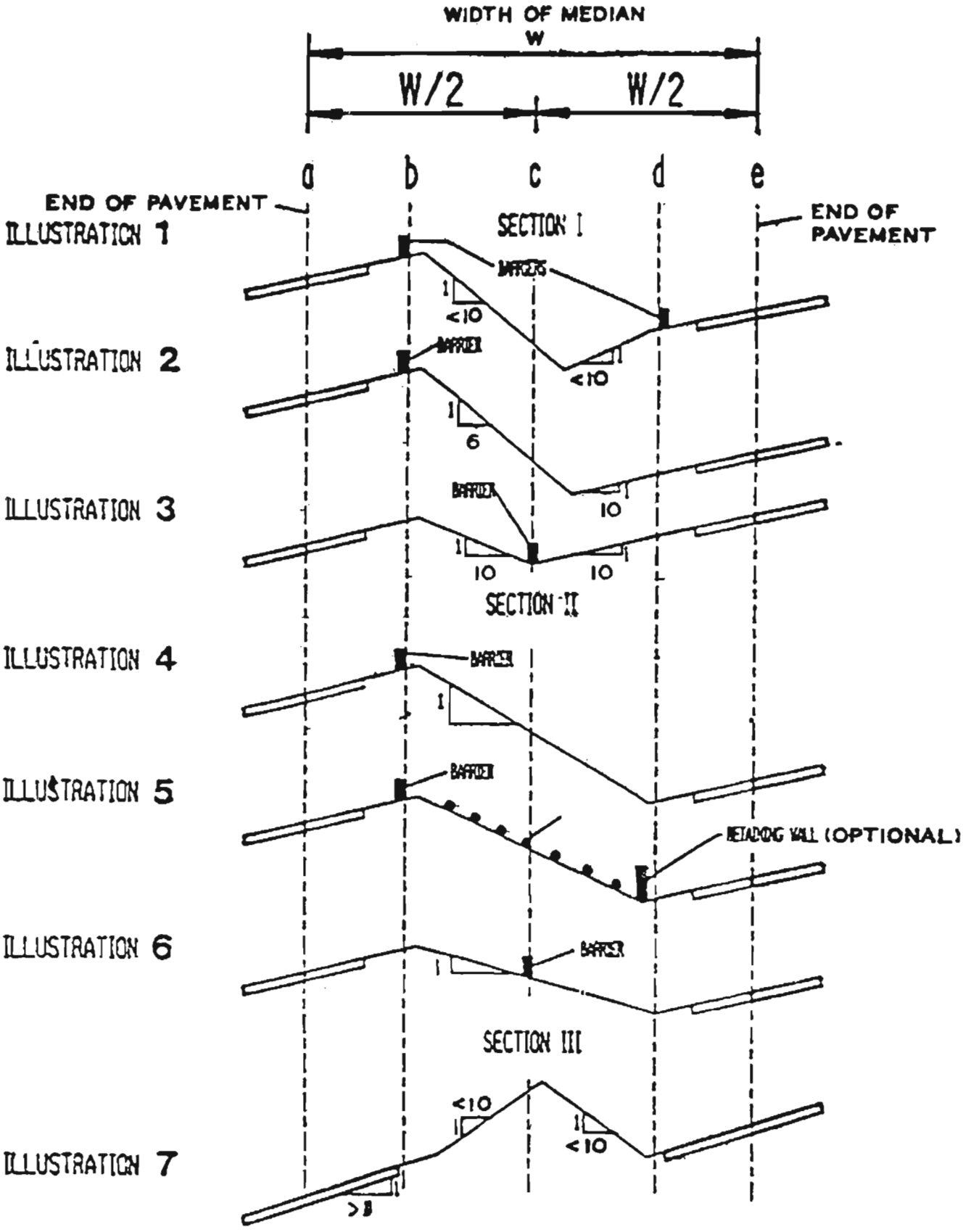


FIG-10 RECOMMENDED MEDIAN BARRIER PLACEMENT
IN NON-LEVEL MEDIANS

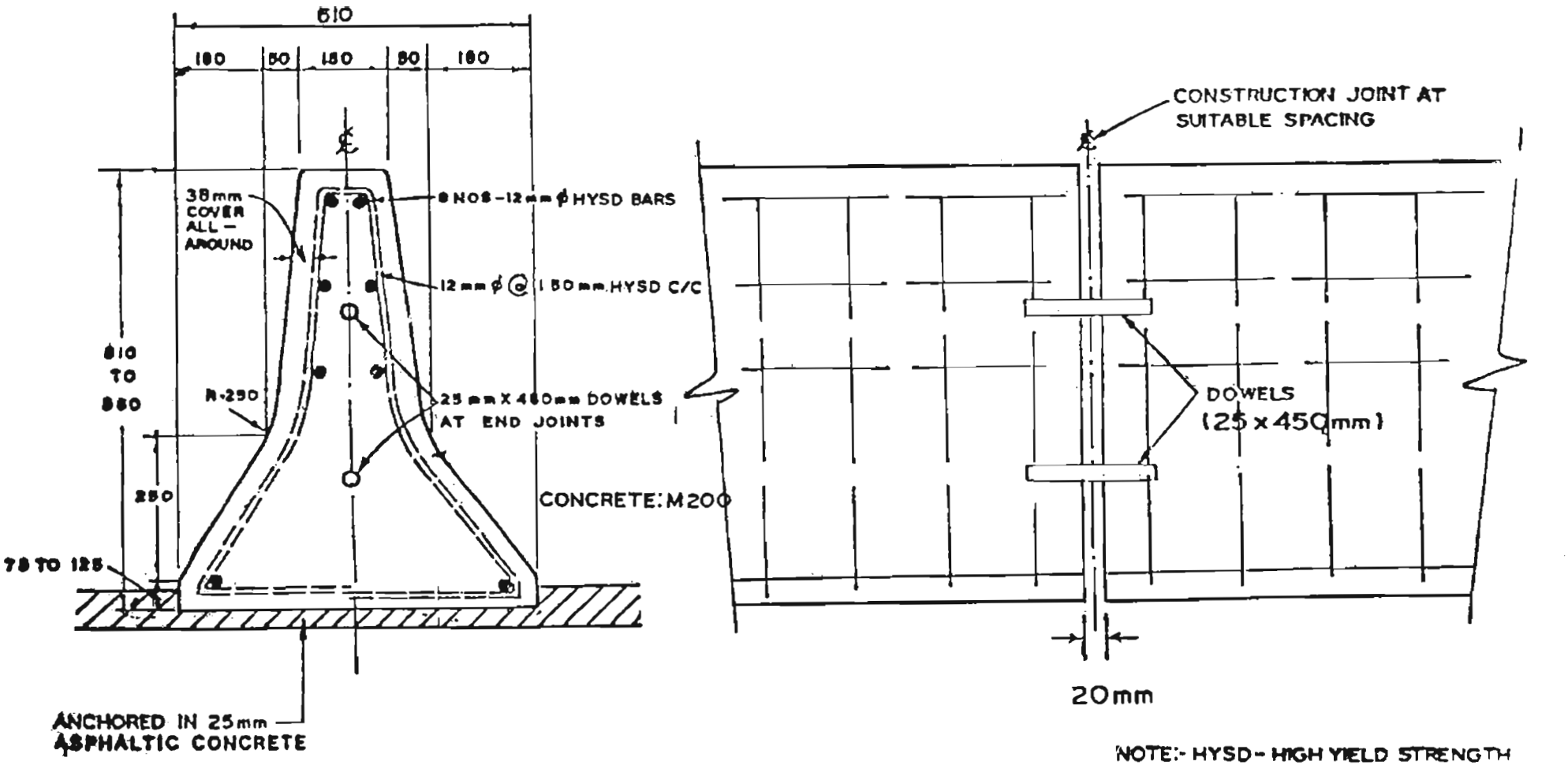
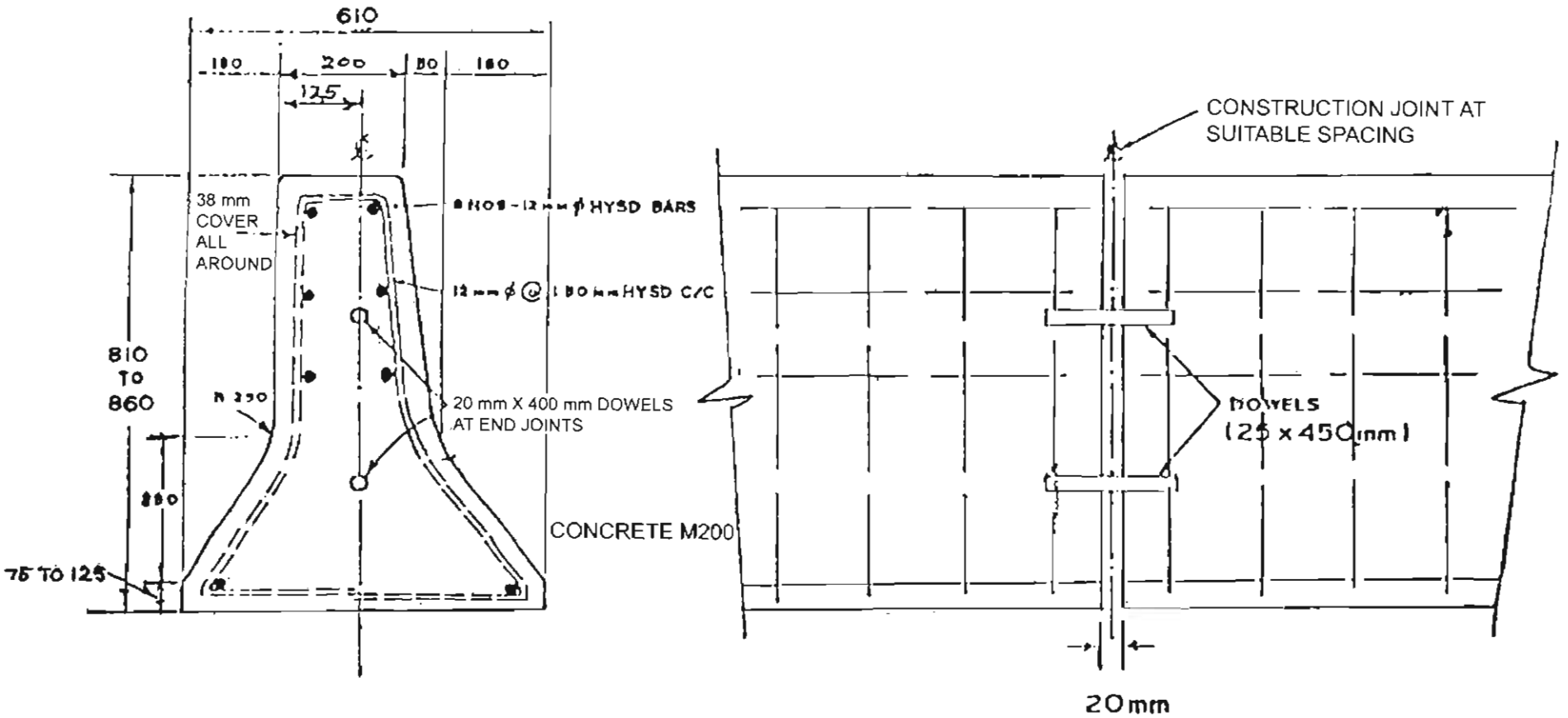


FIG.11 MEDIAN BARRIER CAST-IN-SITU DESIGN

(ALL DIMENSIONS ARE IN mm)



NOTE: HYSD - HIGH YIED STRENGTH DEFORMED REINFORCEMENT

FIG-5 ROADSIDE BARRIER CAST-IN-SITU DESIGN
(ALL DIMENSIONS ARE IN mm)

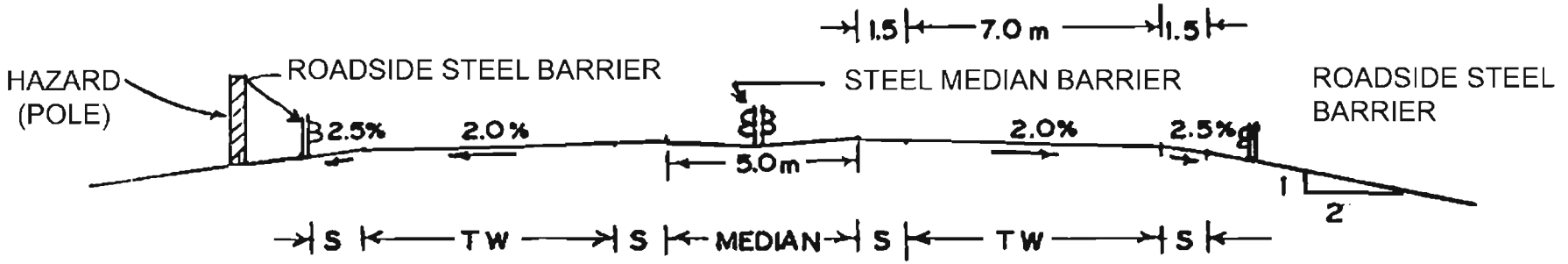


FIG-13 TYPICAL CROSS SECTION DETAILS

(RAISED CURBS OR DRAINS NOT TOBE PROVIDED BETWEEN TRAVEELD WAY AND BARRIER)

S – SHOULDER

TW – TRAVELED WAY