

Name of Work:**M & R to Various Roads of R & B Division, Bhuj (Annual Rate Contract) (Providing Road Furniture work)****Detailed Specifications****Item No.: - 01**

Providing and fixing retro Reflective Engineering grade Board using C.R.C. (M.S.) Sheet 2mm, angle iron 75 x 75 x 6mm. Descaling and degreasing the board as per requirement using epoxyprimer epoxy paint and carrying retro reflective process by screen painting as directed etc. complete including transporting and fixing in C.C.1:4:8 with necessary excavation curing etc. complete as per I.R.C type design.(A) Engineer Grade

Detailed Technical Specifications for Sign Board (MORTH, Section – 801)**1. Material & Manufacturing:****1.1 Scope**

The work shall consist of fabrication, supply and installation of ground mounted traffic signs on roads. The details of the signs shall be as shown in the drawings and in conformity with the code of practice for Road signs, IRC 67-2012.

1.2 Materials

The various materials and fabrication of the traffic signs shall conform to the following requirements:

1.2.1 Concrete:

Concrete for the foundation shall be of M15 Grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.2 Reinforcing Steel

Reinforcing steel shall conform to the requirements of IS: 1786 unless otherwise shown on the drawings

1.2.3 Bolts, Nuts and Washers

High strength Bolts shall conform to IS: 1367 whereas precision bolts, nuts, etc. shall conform to IS: 1364

1.2.4 Plates and Supports

Plates and support sections for the sign posts shall conform to IS: 226 and IS: 2062 or any other relevant IS specifications.

1.2.5 Substrate

Sign panel shall be fabricated on Aluminum sheet, aluminum composite panel, fibre glass sheeting, or sheet moulding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistance aluminum alloy conforming to IS: 736-Material Designation 24345 or 1900. Aluminum composite Material (ACM) sheets shall be sandwiched construction with a thermoplastic core of Low Density Polyethylene (LDPE) between two thick skins/sheets of aluminum with overall thickness of 3mm or 4mm (as specified in the contract), and aluminum skin thickness 0.5mm and 0.3mm respectively on both the sides.

The mechanical proportion of ACM and that of aluminum skin shall conform to the requirements given in the table 800-1, when tested in accordance with the test methods mentioned against each of them.

Table 800-1: Specifications for Aluminum Composite Material (ACM)

SI No.	Description	Specification for 4mm		Specification for 3mm
		Standard test	Acceptable value	Acceptable value
A	Mechanical Properties of ACM			

1	Peel off strength with retro reflective sheeting. (Drum Peel Test)	ASTM D903	Min. 4 N/mm	Min. 4 N/mm
2	Tensile strength	ASTM E8	Min. 40 N/mm ²	Min. 30 N/mm ²
3	0.2% Proof Stress	ASTM E8	Min. 34 N/mm ²	Min. 34 N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5 %
5	Flexural strength	ASTM C393	Min. 130 N/mm ²	Min. 120 N/mm ²
6	Shear strength with Punch shear test	ASTM D732	Min. 18 N/mm ²	Min. 18 N/mm ²
B	Properties of Aluminium Skin			
1	Tensile strength (Rm)	ASTM E8	Min. 150 N/mm ²	Min. 130 N/mm ²
2	Modulus of elasticity	ASTM E8	Min. 70,000 N/mm ²	Min. 70,000 N/mm ²
3	Elongation	ASTM E8	A ₅₀ Min. 2%	A ₅₀ Min. 2%
4	0.2 % Proof Stress	ASTM E8	Min. 110 N/mm ²	Min. 110 N/mm ²

1.2.6 Plate Thickness

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5mm thick Aluminum and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminum and 4 mm thick with Aluminium Composite Material. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under prevailing wind and other loads.

1.2.7 In respect of sign sizes not covered by IRC-67, the structural details (thickness etc.) shall be as per the approved drawings or as directed by the Engineer.

1.3 Traffic signs having Retro Reflective Sheeting

1.3.1 General Requirements

The retro reflective sheeting used on the signs shall consist of white or coloured sheeting having a smooth outer surface, which has the property of retro reflection over its entire surface. It shall be weather resistant and exhibit colour fastness. It shall be new and unused and show no evidence of cracking, scaling, and pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having the sheeting tested for coefficient of retro reflection, daytime colour and luminance, shrinkage, flexibility, liner removal, adhesion, impact resistance, specular gloss and fungus resistance, 3 years outdoor weathering and its having passed these tests shall be obtained from International/Government laboratory/Institute by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens, High Intensity Grade with encapsulated lens or Micro-Prismatic Grade retro reflective element material as given in Clauses 801.3.2 to 801.3.7. Guidance on the recommended application of each class of sheeting may be taken from IRC-67.

1.3.2 High Intensity Grade Sheeting

1.3.2.1 High Intensity Grade (Type III)

This sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent water-proof plastic having a smooth surface or as an unmetallised micro prismatic reflective material elements. The retro-reflective surface after cleaning with soap and water and in dry condition shall have the minimum coefficient of retro-reflection (determined with ASTM D:4956-09) as indicated in Table 800-2.

Table 800-2 Acceptable Minimum Coefficient of Retro-reflection for Type III High Intensity Grade Sheeting^A
(Encapsulated Lens Type)
(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown
0.1° ^B	-4°	300	200	120	54	54	24	14
0.1° ^B	+30°	180	120	72	32	32	14	10
0.2°	-4°	250	170	100	45	45	20	12
0.2°	+30°	150	100	60	25	25	11	8.5
0.5°	-4°	95	62	30	15	15	7.5	5.0
0.5°	+30°	65	45	25	10	10	5.0	3.5

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

^BValues for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent, of the values of retro reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.2.2 High Intensity Micro-Prismatic Grade Sheeting (HIP) (Type IV) :

This sheeting shall be of high intensity retro-reflective sheeting made of micro-prismatic retro-reflective element material coated with pressure sensitive adhesive. 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 D 4956-09) as indicated in Table 800-3.

Table 800-3 Acceptable Minimum Coefficient of Retro-Reflection for
Type IV High Intensity Micro-prismatic Grade Sheeting^A
(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	500	380	200	70	90	42	25	400	300	150
0.1° ^B	+30°	240	175	94	32	42	20	12	185	140	70
0.2°	-4°	360	270	145	50	65	30	18	290	220	105
0.2°	+30°	170	135	68	25	30	14	8.5	135	100	50

0.5°	-4°	150	110	60	21	27	13	7.5	120	90	45
0.5°	+30°	72	54	28	10	13	6	3.5	55	40	22

^AMinimum Coefficient of Retro reflection (R_A)(cd.lx⁻¹.m⁻²).

^BValues for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance

1.3.4 Prismatic Grade Sheeting

1.3.4.1 Prismatic Grade Sheeting (Type VIII)

The reflective sheeting shall be retro reflective sheeting made of micro prismatic retro reflective material. 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 D: 4956-09) as indicated in Table 800-4

Table 800-4 Acceptable Minimum Coefficient of Retro-reflection for Type VIII Prismatic Grade Sheeting^A
(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Green - Yellow -	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	1000	750	375	100	150	45	30	800	600	300
0.1° ^B	+30°	460	345	175	46	69	21	14	370	280	135
0.2°	-4°	700	525	265	70	105	32	21	560	420	210
0.2°	+30°	325	245	120	33	49	15	10	260	200	95
0.5°	-4°	250	190	94	25	38	11	7.5	200	150	75
0.5°	+30°	115	86	43	12	17	5	3.5	92	69	35

^AMinimum Coefficient of Retro reflection (R_A) (cd.lx⁻¹.m⁻²).

^BValues for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance

1.3.4.2 Prismatic Grade Sheeting (Type IX)

The reflective sheeting shall be retro reflective sheeting made of micro prismatic retro reflective material. 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 D 4956-09) as indicated in Table 800-5

Table 800-5 Acceptable Minimum Coefficient of Retro-reflection for Type IX Prismatic Grade Sheeting^A
(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange
0.1° ^B	-4°	660	500	250	66	130	30	530	400	200
0.1° ^B	+30°	370	280	140	37	74	17	300	220	110
0.2°	-4°	380	285	145	38	76	17	300	230	115
0.2°	+30°	215	162	82	22	43	10	170	130	65
0.5°	-4°	240	180	90	24	48	11	190	145	72
0.5°	+30°	135	100	50	14	27	6	110	81	41
1.0°	-4°	80	60	30	8	16	3.6	64	48	24
1.0°	+30°	45	34	17	4.5	9.0	2	36	27	14

^AMinimum Coefficient of Retro reflection (R_A) (cd.lx⁻¹.m⁻²).

^BValues for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values, of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3 Prismatic Grade Sheeting (Type XI)

Retro reflective sheeting typically manufactured as a cube corner. The reflective sheeting shall be retro reflective sheeting made of micro prismatic retro reflective material. 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 D 4956-09) as indicated in Table 800-6

Table 800-6 Acceptable Minimum Coefficient of Retro-reflection for Type XI Prismatic Grade Sheeting^A (Candelas per Lux per Square Metre)

Observation Angle	Entrance Angle	white	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent yellow-Green	Fluorescent yellow	Fluorescent Orange
0.1° ^B	-4°	830	620	290	83	125	37	25	660	500	250
0.1° ^B	+30°	325	245	115	33	50	15	10	260	200	100
0.2°	-4°	580	435	200	58	87	26	17	460	350	175

0.2°	+30°	220	165	77	22	33	10	7	180	130	66
0.5°	-4°	420	315	150	42	63	19	13	340	250	125
0.5°	+30°	150	110	53	15	23	7	5	120	90	45
1.0°	-4°	120	90	42	12	18	5	4	96	72	36
1.0°	+30°	45	34	16	5	7	2	1	36	27	14

^AMinimum Coefficient of Retro reflection (R_A) ($\text{cd.lx}^{-1}.\text{m}^{-2}$).

^BValues for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values, of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.5 Adhesive

The sheeting shall have a pressure-sensitive adhesive of the aggressive-tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, 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. The sheeting shall be applied in accordance with the manufacturer's specifications.

1.3.6 Fabrication

Surface to be reflectorised shall be effectively prepared to receive the retro-reflective sheeting. The aluminium sheeting shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt joint shall be used. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

1.3.7 Message / Border

The messages (legends, letters, numerals, etc.) and borders shall either be screen-printed or of cut out from durable transparent overlay or cut out from the same type of reflective sheeting for the cautionary/mandatory sign boards. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the informative and other sign boards, the messages (legends, letters, numerals etc.) and borders shall be cut out from durable transparent overlay film or cut-out from the same reflective sheeting only. Cut-outs shall be from durable transparent overlay materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent coloured areas on white sheeting, the co-efficient of retro-reflection shall not be less than 50 per cent of the corresponding values in Tables 800-2 to 800-6 as applicable. Cut-out messages and borders, wherever used, shall be either made out of retro-

reflective sheeting or made out of durable transparent overlay except those in black which shall be of non-reflective sheeting or opaque in case of durable transparent overlay.

1.3.8 Color for Signs

1.3.8.1 Signs shall be provided with retro-reflective sheeting and/or overlay film/screening ink as shown on the detailed drawings. The reverse side of all signs shall be painted grey

Table 8.1 Specification Limits (Daytime)^A

Colour	1		2		3		4		Daytime Luminance Factor (Y%)	
	X	y	x	y	X	y	x	y	Min	Max
<i>White</i>	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329	15	--
<i>Yellow</i>	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472	24	45
<i>Green^B</i>	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771	2.5	11
<i>Red</i>	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346	2.5	11
<i>Blue^B</i>	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216	1	10
<i>Orange</i>	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404	12	30
<i>Brown</i>	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390	1	6
<i>Fluorescent Yellow-Green</i>	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540	60	--
<i>Fluorescent Yellow</i>	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442	45	--
<i>Fluorescent Orange</i>	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	25	--

1.3.8.2 Except in the case of railway level crossing signs (for which the colour scheme is given later) the sign posts shall be painted in 250 mm wide bands, alternately black and white. The lowest band next to the ground shall be in black

1.3.8.3 The colour of the material shall be located within the area defined by the chromaticity coordinates in Table 8.1 and comply with the luminance factor given in Table 800-7 when measured as per ASTM D: 4956-09

The colours shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night.

1.3.8.4 The mandatory and warning signs shall be provided with white background and red border. The legend/symbol for these signs shall be in black

1.3.8.5 The colours chosen for informatory or guide signs shall be distinct for different categories of roads. For National Highways and State Highways, these signs shall be of green background with white borders, legends and word messages. For Expressways these signs shall be of blue background with white border, legends and word messages.

1.3.9 Refurbishments

Where existing signs are specified for refurbishments, the sheeting shall have semi-rigid aluminum backing or materials as per clause 1.2.5, pre-coated with aggressive tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the signs and should thoroughly bond with that material.

1.3.10 Sizes of Letters

1.3.10.1 Letter size should be chosen with due regard to the speed, classification and location of the road, so that the sign is of adequate size for legibility but without being too large or obtrusive. The size of the letter, in terms of x-height, to be chosen as per the design speed is given in Table 800-8.

Table 800-8 Acceptable Limits for Size of Letters and Visibility Distance

Design Speed (kmph)	Minimum 'x' Height of the Letters (mm)	Minimum Sight Distance / Clear visibility distance (m)	Maximum Distance from Centre Line (m)
40	100	45	12
50	125	50	14
65	150	60	16
80	250	80	21
100	300	90	24
120	400	115	32

The thickness of the letters and their relation to the x-height, the width and the heights are indicated in Table IV (a) of the Annexure-IV to facilitate the design of the informatory signs and definition plates.

1.3.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for National and State Highways and 100 mm for other roads. In case of overhead signs, the size ('X' height) of letters may be minimum 300 mm. Thickness of the letter could be varied from 1/6 to 1/ 5 of the letter 'x' size. The size of the initial uppercase letter shall be 1-1/3 times x-height. In urban areas, letter size shall be 100 mm on all directional signs. For easy and better comprehension, the word messages shall be written in initial upper case letter followed by lower case letters.

1.3.10.3 Letter size on definition plates attached with normal sized signs should be 100 mm or 150 mm. In the case of small signs, it should be 100 mm. Where the message is long, as for instance in "NO PARKING" and "NO STOPPING" signs, the message may be broken with two lines and the size of letters may be varied in the lines so that the definition plate is not too large. The lettering on definition plates will be all in upper case letters.

1.3.11 Warranty and Durability

The Contractor shall obtain from the original manufacturer of the Retro Reflective sheeting for period of ten (10) years warranty for satisfactory field performance including stipulated retro reflectance of Micro-Prismatic sheeting and a Seven years warranty for High Intensity Grade and submit the same to the Engineer. The warranty shall be inclusive of the screen printed or cut out letters/legends and their bonding to the retro reflective sheeting. The contractor shall also furnish LOT numbers and certificate that the signs and material supplied against the assigned work meet all the stipulated requirements and carry the stipulated warranty and the contractor/supplier is the authorized converter of the particular sheeting.

All the signs shall be dated during the fabrication with indelible marking to indicate the start of the warranty. The warranty shall also cover the replacement obligation by the sheeting manufacturer as well as contractor for replacement/repair/restoration of the retro reflective efficiency.

A certificate in original shall be given by the manufacturer of the sheeting that its offered retro-reflective sheeting has been tested for various parameters such as co-efficient of retro reflection, day/night time color and luminance, shrinkage , flexibility, liner removal , adhesion, impact resistance, specular gloss and fungus resistance.; the tests shall be carried out by a Government laboratory in accordance with the various ASTM procedures and the results must show that the sheeting has passed the requirements for all the above mentioned parameters. A copy of the test reports shall be attached with the certificate.

1.4 Installation

1.4.1 The traffic signs shall be mounted on support posts, which may be of GI pipes conforming to IS 1239, Rectangular Hollow Section conforming to IS 4923 or square hollow Section conforming to IS 3589. Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 square metre shall be mounted on a single post, and for greater area, two or more supports shall be provided. Post End(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

1.4.2 All components of signs and supports, other than the reflective portion of GI posts shall be thoroughly desealed, cleaned, primed and painted with two coats of epoxy paint. Any part of post below ground shall be painted with protective paint.

1.4.3 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.

1.5 Measurement for Payment

The measurements of standard cautionary, mandatory and information signs shall be in number of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by **per Number**

1.6 Rate

The Contract unit rate shall be payment in full for the cost of making the road sign, including all materials, installing it at the site and incidentals to complete the work in accordance with the Specifications.

❑ Special Requirement for the Retro Reflective Sign Boards Work on the Project

1. The Sign Board Manufacturer / supplier should be Authorized converter / Dealer of the Original Retro reflective sheeting manufacturer only. The certificate should be issued by the retro reflective sheeting manufacturer its subsidiary in India. Certificate issued by distributor dealer/power of attorney holder shall be invalid.
2. The sign Board manufacturer / supplier should have in-house facility to manufacture the signages and details of the same to be submitted for source approval.
3. A seven year pre-qualification warranty for Class-B Type-4 (HIP) reflective sheeting and / or A Ten years Pre-qualification warranty for Class-C Type-11 (DG3) reflective sheeting as applicable, in original, issued by the retro reflective sheeting manufacturer or its subsidiary in India. The warranty shall be for Micro prismatic retroreflective sheeting confirming to ASTM D-4956- 09. The warranty should be in original and jointly signed by the authorized converter.

4. The Sign Board Manufacturer has to submit the Test reports for Retro Reflective sheeting used in the project attested by the original manufacturer or its subsidiary in India.
5. The Sign Board Manufacturer has to submit Sample of Reflective sheeting going to be used for the project of size (1ft x 1ft) for source approval.
6. At the completion of the work, the Sign Board Manufacturer has to submit the, in original, actual warranty certificate for retro reflective sheeting Class-B Type-4 High Intensity Grade and / or Class-C Type-11 (DG3) for all the sign boards for period of 7 years / 10 years respectively jointly signed by the manufacturer of the sheeting and Authorized converter along with the usage conformance / LOT certificate confirming quantity of various types of boards installed on the project.
7. At the completion of the work, The bidder has to submit the proof of purchase for the Retro –Reflective sheeting along with their final bill.
8. The Sign Board Manufacturer should organize onsite testing for the reflectivity performance of the Retro Reflective sheeting used on the project with reflectometer initially within 7 days of completion of work and afterwards at interval of every 1 year till the warranty period.

TEST SCHEDULE

Sr. No.	Materials	Code of Practice	Onsite / Laboratory	Name of Laboratory Test	Reference Table	Frequency of Test																																																																																																																
1	2	3	4	5	6	7																																																																																																																
1	Retro Reflective Sheeting for the Signage	IRC 67: 2012; ASTM D-4956	On Site Testing with Reflectometer make: Delta, Zehntner, Roadvista – complying to ASTM D 4956	Co-efficient of Retro Reflection	<p style="text-align: center;">Class-B type-4 High Intensity Grade</p> <table border="1"> <thead> <tr> <th>Observation Angle</th><th>Entrance Angle</th><th>White</th><th>Yellow</th><th>Green</th><th>Red</th><th>Blue</th></tr> </thead> <tbody> <tr> <td>0.1°^B</td><td>-4°</td><td>500</td><td>380</td><td>70</td><td>90</td><td>42</td></tr> <tr> <td>0.1°^B</td><td>+30°</td><td>240</td><td>175</td><td>32</td><td>42</td><td>20</td></tr> <tr> <td>0.2°</td><td>-4°</td><td>360</td><td>270</td><td>50</td><td>65</td><td>30</td></tr> <tr> <td>0.2°</td><td>+30°</td><td>170</td><td>135</td><td>25</td><td>30</td><td>14</td></tr> <tr> <td>0.5°</td><td>-4°</td><td>150</td><td>110</td><td>21</td><td>27</td><td>13</td></tr> <tr> <td>0.5°</td><td>+30°</td><td>72</td><td>54</td><td>10</td><td>13</td><td>6</td></tr> </tbody> </table> <p style="text-align: center;">Class-C Type-11 Micro Prismatic Grade</p> <table border="1"> <thead> <tr> <th>Observation Angle</th><th>Entrance Angle</th><th>White</th><th>Yellow</th><th>Green</th><th>Red</th><th>Blue</th></tr> </thead> <tbody> <tr> <td>0.1°^B</td><td>-4°</td><td>830</td><td>620</td><td>83</td><td>125</td><td>37</td></tr> <tr> <td>0.1°^B</td><td>+30°</td><td>325</td><td>245</td><td>33</td><td>50</td><td>15</td></tr> <tr> <td>0.2°</td><td>-4°</td><td>580</td><td>435</td><td>58</td><td>87</td><td>26</td></tr> <tr> <td>0.2°</td><td>+30°</td><td>220</td><td>165</td><td>22</td><td>33</td><td>10</td></tr> <tr> <td>0.5°</td><td>-4°</td><td>420</td><td>315</td><td>42</td><td>63</td><td>19</td></tr> <tr> <td>0.5°</td><td>+30°</td><td>150</td><td>110</td><td>15</td><td>23</td><td>7</td></tr> <tr> <td>1.0°</td><td>-4°</td><td>120</td><td>90</td><td>12</td><td>18</td><td>5</td></tr> <tr> <td>1.0°</td><td>+30°</td><td>45</td><td>34</td><td>5</td><td>7</td><td>2</td></tr> </tbody> </table>	Observation Angle	Entrance Angle	White	Yellow	Green	Red	Blue	0.1° ^B	-4°	500	380	70	90	42	0.1° ^B	+30°	240	175	32	42	20	0.2°	-4°	360	270	50	65	30	0.2°	+30°	170	135	25	30	14	0.5°	-4°	150	110	21	27	13	0.5°	+30°	72	54	10	13	6	Observation Angle	Entrance Angle	White	Yellow	Green	Red	Blue	0.1° ^B	-4°	830	620	83	125	37	0.1° ^B	+30°	325	245	33	50	15	0.2°	-4°	580	435	58	87	26	0.2°	+30°	220	165	22	33	10	0.5°	-4°	420	315	42	63	19	0.5°	+30°	150	110	15	23	7	1.0°	-4°	120	90	12	18	5	1.0°	+30°	45	34	5	7	2	5 Tests (1 Sample of Each Color) for every 1 km.
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Item No. – 79

Road marking with hot applied thermoplastic paints with reflectorising glass beads on bitumin surface providing and laying a hot applied thermoplastic compound 2.5 mm thick including reflectorising glass beads @ 250gms per sqm area, thickness of 2.5mm is excluding of surface applied glass beds as per IRC:35-2015. The finished surface to be level, uniform and free from streaks and holes. zebra patta /bump patta lane/center line/ edge line/cut patta. The white color marking should provide liminance coefficinet on cemend road shall be min 130 mcd/m2/lux and Asphalt road shall be min 100 mcd/m2/lux during the service life during the day time. The marking should meet the performance criteria for night time reflectivity, wet reflectivity and skid resistance as mentioned in the section-15 of IRC 35-2015. Warranty for the Retro reflectivity should be two years.

ROAD MARKINGS :-

General :-The colour, width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC : 35 - 2015, and as specified in the drawings or as directed by the Engineer.

Materials :-

Road markings shall be of ordinary road marking paint, hot applied thermoplastic compound, or reflectorised paint as specified in the item and the material shall meet the requirements as specified below.

Hot Applied Thermoplastic Road Marking :-

General:-

- (i) The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.
- (ii) The thermoplastic compound shall be screened extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
- (iii) The colour of the compound shall be white or yellow OS colour No. 356) as specified in the drawings or as directed by the Engineer.
- (iv) Where the compound is to be applied to cement concrete pavement, a scaling primer is recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before die- ftrwkings am applied

Thermoplastic Material:

General:- The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads

Requirements:-

Composition: The pigment, beads and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table below:

Table : PROPORTIONS OF CONSTITUENTS OF MARKING MATERIAL

(Percentage by weight)

Component	White	Yellow
Binder	18.0 Min.	18.0 Min.
Glass Beads	30-40	30-40
Titanium Dioxide	10.0 min.	--

Calcium Carbonate and Inert fillers	42.0 Max.	Refer Note
Yellow Pigments	--	Refer Note

Note:- Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this specification are met.

Properties:- The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262-(Part-I), shall be as below:

(i)(a) Luminance:-

White: Day light luminance at 45 degree-65 per cent min. as per AASHTO M-249

Yellow: Day light luminance at 45 degrees-45 per cent min. as per AASHTO M-249.

(b) Drying time: When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

(c) Skid resistance: not less than 45 as per BS 6044.

(d) Cracking resistance at low temperature: The material shall show no cracks on application to concrete blocks.

(e) Softening point: 102.5;±9.5 degree C as per ASTM D-36.

(f) Flow resistance: Not more than 25 per cent as per AASHTO M-249.

(ii) Yellowness index (for white thermoplastic paint): not more than 0.12 as per AASHTO M-249.

(iii) Storage life:-The material shall meet the requirements of these specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/contractor.

(iv) Reflectorisation:- Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Reflectorising glass beads.

(v) Marking:- Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:

1. The name, trade mark or other means of identification of manufacturer
2. Batch number
3. Date of manufacturer
4. Colour (white or yellow)
5. Maximum application temperature and maximum safe heating temperature.

(vi) Sampling and testing: The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The contractor shall furnish to the employer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this specification.

REFLECTORISING GLASS BEADS:-

General:- This specification covers two types of glass beads to be used for the production of reflectorised pavement markings.

Type-1 beads are those which are a constituent of the basic thermoplastic compound vide above table and beads are those which are to be sprayed on the surface vide Clause table.

The glass beads shall be transparent, colourless and free from milkiness, dark particles and excessive air inclusions.

These shall conform to the requirements spelt out in Clause table.

Specific requirements:-

(A) Gradation:- The glass beads shall meet the Gradation requirements for the two types as given table below:

GRADATION REQUIREMENTS FOR GLASS BEADS

Sieve Size	Per Cent retained	
	Type-1	Type-2
1.18 mm	0 to 3	--
850 Micron	5 to 20	0 to 5
600 Micron	--	5 to 20
425 Micron	65 to 95	
300 Micron	--	30 to 75
180 Micron	0 to 10	10 to 30
below 180 Micron	---	0 to 5

(B) Roundness:- The glass beads shall have a minimum of 70 per cent true spheres.

(C) Reflective Index:-The glass beads shall have a minimum reflective index of 1.50.

(D) Free flowing properties:-The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow test.

Test Methods: The specific requirements shall be tested with the following methods:

- (i) Free flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter desiccator which is filled within 25 mm of the top of a desiccator plate with sulphuric acid water solution. Cover the desiccator and let it stand for 4 hours at 20 to 29 degree C. Remove sample from desiccator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be essentially free of lumps and clusters and shall flow freely through the funnel.
- (ii) The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS 3262 (Part-I).
- (iii) The Contractor shall furnish to the employer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of this specification. However, if so required, these tests may be carried out as directed by the Engineer.

Application properties of thermoplastic material:-

The thermoplastic material shall readily get screeded/extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges. The material upon heating to application temperatures, shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

Preparation:-

- (i) The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.

(ii) After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

Properties of finished road making:-

- (a) The stripe shall not be slippery when wet.
- (b) The making shall not lift from the pave in freezing weather.
- (c) After application and proper drying, the stripe shall show no appreciable deformation or discolouration under traffic and under road temperatures upto 60 degree C.
- (d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.
- (e) The stipe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- (f) The colour of yellow marking shall conform to IS Colour No.356 as given in IS-164.

APPLICATION:

- i) Marking shall be done by machine. For locations where painting cannot be done machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.
- ii) The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.
- iii) The pavement temperature shall not be less than 10 degree C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign material before application of the paint.
- iv) The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall so bond itself to the old line that no splitting or separation takes places.
- v) Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type-2, conforming to the above noted specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square meter area.
- vi) The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices B and C of BS-3262 (Part-3).
- vii) The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks upper surface of the lines shall be level, uniform and free from streaks.

Marking:- Marking like lane markings, centre line marking and edge line marking shall be done strictly as prescribed in IRC-35-2015

Performance Criteria

The performance criteria given below are applicable for the white color pavement markings only.

1. Daytime Visibility: The luminance co-efficient under diffuse illumination Q_d for road marking on
 - a. Cement Road, shall be min of 130 mcd/m²/lux during the expected life service time
 - b. Asphalt Road, shall be min of 100 mcd/m²/lux during the expected life service time

2. Nighttime Visibility:

i) Dry Retro Reflection

Dry retroreflectivity shall be compliant with Table 15.1 of IRC 35-2015 and measured in accordance with the method described in Annexure E of IRC 35-2015.

Table: 15.1 Initial and Min. performance for Dry retro reflectivity during nighttime

S.No.	Design Speed	RL Retro Reflectivity (mcd/m ² /lux)	
		Initial (7 days)	Min Threshold Level (TL) and warranty Period Required upto 2 years
1	Up to 65	200	80
2	65-100	250	120
3	Above 100	350	150

MEASUREMENTS AND PAYMENT:-

The painted marking shall be measured in **Square Meters (Sq.Mtr.)** of actual area marked (excluding the gaps, if any). In respect of marking like directional arrows and lettering etc, the measurement shall be by numbers. Contractor shall have to submit the manufacture test certificate before starting the work at no extra cost. Contractor shall have to submit the test report of both thermoplastic paint and glass beads from approved laboratory for paint 7 glass beads at no extra cost before producing bill and then after on end when asked.

Rate:-

The contract unit rate for road markings shall be payment in full compensation for furnishing all labour, materials, tools, equipment including all incidental costs necessary for carrying out the work at the site conforming to these specifications complete as per the approved drawings or as directed by the Engineer and all other incidental costs necessary to complete the work to these specification.

☐ **Special Requirement for Hot Applied Thermoplastic Marking and Audible Vibratory Profile Marking Application on Road**

1. The application of Hot Applied Thermoplastic and Audible Vibratory marking must be done with Either Fully Automatic or Semi-Automatic Application Machine only. No Manual Machine is allowed to use for the application of the Thermoplastic marking.
2. The Applicator must have their own machines for Thermoplastic profile Marking, and the proof of ownership to be submitted to the Authority for source approval.
3. The Applicator should be either Manufacturer or authorized by the original manufacturer of the Material. The applicator should submit such authorization certificate to the Authority for the approval before commencing the work.
4. The manufacture should be ISO certified organization and the copy of the certificate should be submitted to the Authority.
5. Performance Criteria: Material should be confirming to MoRTH specification and test Certificate should be submitted as per the IRC 35-2015 for the reflectivity and luminance test time to time.
6. The Applicator should organize onsite testing for the reflectivity performance with reflectometer initially at 7 days and afterwards at interval of every 6 months up to 2Years. And performance should meet IRC 35-2015 criteria.

7. The Applicator should submit in original warranty for satisfactory in field performance as laid down in IRC 35-2015 for the period of 2 years. The warranty should be in original and jointly signed by the original manufacture and authorized applicator.

TEST SCHEDULE

Sr.No.	Materials	Code of Practice	Onsite / Laboratory	Name of Laboratory Test	Reference Table	Frequency of Test															
1	2	3	4	5	6	7															
1	Hot Applied Thermoplast Road Marking	IRC 35: 2015; Section 800 of MORTH	On Site Testing with Reflectometer	(RL) Retro Reflectivity (mcd/m2/lux	Retro Reflectivity (mcd/m2/lux <table><tr><th>Design Speed</th><th>Initial (7 days)</th><th>Min Threshold Level (TL) Upto 2 years</th></tr><tr><td>Upto 65 kmph</td><td>200</td><td>80</td></tr><tr><td>65-100</td><td>250</td><td>120</td></tr></table>	Design Speed	Initial (7 days)	Min Threshold Level (TL) Upto 2 years	Upto 65 kmph	200	80	65-100	250	120	Max. 6 (Six) Tests to be conducted per Km						
		Design Speed	Initial (7 days)	Min Threshold Level (TL) Upto 2 years																	
		Upto 65 kmph	200	80																	
65-100	250	120																			
		IRC 35:2015; Section 800 of MORTH	Laboratory Testing	Proportions of Constituents of Marking Material	<table><tr><th>Component</th><th>White</th><th>Yellow</th></tr><tr><td>Binder</td><td>18.0 Min</td><td>18.0 Min</td></tr><tr><td>Glass Beads</td><td>30-30</td><td>30-30</td></tr><tr><td>Titanium Dioxide</td><td>10.0 Min</td><td>--</td></tr><tr><td>Calcium Carbonate and Inert Filler</td><td>42.0 Max</td><td>--</td></tr></table>	Component	White	Yellow	Binder	18.0 Min	18.0 Min	Glass Beads	30-30	30-30	Titanium Dioxide	10.0 Min	--	Calcium Carbonate and Inert Filler	42.0 Max	--	1 sample for each color
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Titanium Dioxide	10.0 Min	--																			
Calcium Carbonate and Inert Filler	42.0 Max	--																			
		IRC 35:2015; Section 800 of MORTH	On Site Testing	Skid Resistance	Not less than 45 BPN (British Pendulum Number) as per BS:6044	Every 1 km for each color															

Item No.: - 80

Cat Eye / Road Stud / RPM: Supplying Raised Pavement Markers made of polycarbonate and ABS moulded body and reflective panels with Micro prismatic lens (No Glass bead lens) capable of providing total internal reflection of the light entering the lens face and shall support a load of 13635 kgs. tested in accordance to ASTM D 4280 Type H and complying to Specifications of Category A of MORTH Circular No RW/NH/33023/10-97 & DO III Dt 11.06. 1997. The height, width and length shall not exceed 20 mm, 130 mm and 130 mm and with minimum reflective area of 13 Sqcm on each side and the slope to the base shall be 35 +/- 5 degree. The body of the marker should having finger grip for easy and accurate placement and application with epoxy / bituminous Adhesive as recommended by the manufacturer of the marker. The color of the marker should be as per the IRC 35-2015 and as directed by Engineer-in-charge.

Material & Manufacturing**1. Scope**

The work shall cover the providing and fixing of Raised Pavement marker (RPM) or road stud, a device which is bonded to or anchored within the road surface, for lane marking and delineation for night-time visibility, as specified in the contract.

2. Material

2.1 Plastic body of RPM road stud shall be molded from ASA (Acylicstyreneactylonitrile) or HIPS (Impacts polystyrene) or ABS or any other suitable material approved by the Engineer in charge. The marker shall support a load of 13635 kg. tested in accordance with ASTM D 4280

2.2 Reflective panels shall consist if number or lenses containing single or dual prismatic cubes capable of providing total internal reflection the light entering the lens face lenses shall be molded of methyl methecrylat conforming to ASTM D 788 or equivalent.

3. Design

The slope or retro reflecting surface shall prfeably be 35. + 5degree to base. The area of each retro reflecting surface shall not be less than 13.0 sqmt.

4. Optical performance**4.1 Unidirectional and bi directional studs :**

Each reflector or combination of reflector on each face of the stud shall have a CIL not less the given in Table 1 or 2 appropriate.

4.2 Omni directional studs

Each omni directional stud shall have a min. CIL of not less than 2mcd/lx

Table 1 min. CIL vales for category 'A' studs.

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 5° L&R	0.3°	220	110	44
0° U 10° L&R	0.5°	120	60	24

Table 2 min. CIL vales for category 'B' studs.

Entrance Angle	cvObservation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 6° L&R	0.3°	20	10	4
0° U 10° L&R	0.5°	15	7.5	3

Note:

- 1) The entrance angle of 0° U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.
- 2) The stud incorporating one or more corner cube reflectors shall be included in category 'A'. the stud incorporating one or more bi-convex reflectors shall be included in category 'B'.

5. Tests

5.1 Coefficient of luminance intensity can be measured by produce described in ASTM 809 " Practice for Measuring Photometric characteristics" or as recommended in BS 879 part 4:1973

5.2 under test conditions, a stud shall not be considered to fail the photometric requirements if the measured C.I.L at any one position of measurements is less than the values specified in Table 1 or 2 provided that

- i) the value is not less than 80 percent of the specified minimum and
- ii) the average of the left and right measurements for the specific angle is greater than the specified minimum

6. Solar Powered Road Markers (Solar Studs)

The solar studs shall be made of Aluminium alloy and poly carbonate material which shall be absolutely weather resistant and strong enough to support a load of 13,635 kg tested in accordance with ASTM D4280. Its colour may be white, red, yellow, green or blue or combination as directed by the Engineer. Its water resistance shall meet the requirements of IP 65 in accordance with IS:12063:1987 Category 2 for protection against water ingress. The dimensions of solar studs shall not be less than 100 mm x 100 mm x 10 mm. It shall have super bright LEDs so as to provide long visibility from a distance of more than 800 m. Its flashing rate shall not be less than 1 Hz. Its should be able to give the prescribed performance in the temperature range of -40°C to +55°C. Its life shall be not less than 3 years.

7. Fixing of Reflective studs

7.1 Requirements

The enveloping profile of the head of the stud shall be smooth and the studs shall not present anysharp edges to traffic. The reflecting portion of the studs shall be free from crevices or ledges where dirt might accumulate. Marker height shall not be less than 10mm and shall not exceed 20mm. and it's width should not exceed 130mm. the base of the marker shall be flat within 1.3mm. if the bottom of the marker is configured, the outer most faces of the configurations shall not deviate more than 1.3mm from the flat surface. The marker shall be fitted with two polymer shanks at appropriate places at either ends and shall be slotted along its length. The Shank Length for Each of the shanks shall not be less than 20 millimeter.

All road studs shall be legibly marked with name, trade mark or other means of identifications of the manufacturer.

7.2 Placement

The reflective marker shall be fixed to the road surface using the adhesives and the procedure recommended by the manufacturer. No nails should be used to fix the marker so that they do not pose safety hazard on the roads.

Regardless of the type of adhesive used, the markers shall not be fixed if the pavement is not surface dry and on new asphalt concrete surface until the surface has been opened to traffic for a period of not less than 14 hours. The portions of the Road surface to which a marker is to be bonded by the adhesive shall be free of dirt, curing compound, grease, oil, moisture, loose or any other material which would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the Cleaned pavement surface or on the bottom of the markers in a quantity sufficient to result in complete coverage of the area of the contact of the better surface with no voids present at a slight excess after the better surface has been lightly pressed in place. For epoxy installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed.

7.3 Warranty and Durability

The contractor shall obtain from the manufacturer a two year warranty for contractor held performance including stipulated retro reflectance of the reflecting panel and submit the same to the Engineer in charge. In addition a two year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carried out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or low their reflectivity compared to stipulated standards, the contractor would be required to replace all such marker within 15 days of the intimation from the Engineer at his own cost.

8. Measurement of Payment

The measurement of reflective road markers shall be in number of different types of marker supplied and fixed.

9. Rate

The contract unit rate for reflective road marker shall be payment in full compensation for furnishing all labor, materials, tools, equipment including incidental costs necessary for carrying out the work at site conforming to the specifications complete as per approved drawings or as directed by the Engineer.

□ Special Requirements for the Cat Eye/ Road Stud / RPM Application

1. The applicator of the Cat Eye should be authorized Applicator/ Converter of the original manufacturer of the Cat Eye / road studs and copy of the certificate has to be submitted to authority for source approval.
2. For Cat eye with twin molded Shanks application the anchorage should be provided by drilling with the Drilling machine only and not manually.
3. The applicator use the epoxy adhesive or fixing of the Cat eye / RPM as recommended by the original manufacturer only. No other adhesive should be allowed to use on the road.
4. Performance Criteria: Material should be conforming to MoRTH specification and test Certificate should be submitted as per the IRC 35-2015 for the reflectivity and luminance test time to time. The Applicator should submit a letter in original issued by the original manufacturer of the RPM / Cat Eye for the same before commencing the work.
5. The applicator should submit warranty for satisfactory in field performance as laid down in IRC 35-2015 for the period of 2 years. The warranty should be in original and jointly signed by the original manufacture and authorized applicator.

TEST SCHEDULE

Sr. No.	Materials	Code of Practice	Onsite / Laboratory	Name of Laboratory Test	Reference Table	Frequency of Test																				
1	2	3	4	5	6	7																				
1	Road Studs / Cat eyes / RPM (Raised Pavement Marker)	IRC 35:2015; ASTM D4280	Laboratory Testing	Compressive Strength	Compressive Strength (Breaking load) – 13635kgf without breakage	1 Sample for each color																				
		IRC 35: 2015; ASTM D4280	Laboratory Testing	Flexural Strength	909kgf without breakage or significant deformation (3.3mm)	1 Sample for each color																				
		IRC 35:2015; ASTM D4280	Laboratory Testing	Resistance to Lens Cracking, Lens Impact Strength	No More than 2 radial cracks longer than 6.4mm	1 Sample for each Color																				
		IRC 35: 2015; ASTM D4280	Laboratory Testing	Co-efficient of Luminous Intensity – ASTM D4280	Co-efficient of Luminous Intensity (C.I.L) <table><tr><th>Observation Angle</th><th>Entrance Angle</th><th>White</th><th>Yellow</th><th>Red</th></tr><tr><td>0.2</td><td>0</td><td>279</td><td>167</td><td>70</td></tr><tr><td>0.2</td><td>+20</td><td>112</td><td>67</td><td>28</td></tr><tr><td>0.2</td><td>-20</td><td>112</td><td>67</td><td>28</td></tr></table>	Observation Angle	Entrance Angle	White	Yellow	Red	0.2	0	279	167	70	0.2	+20	112	67	28	0.2	-20	112	67	28	1 Sample for each Color
		Observation Angle	Entrance Angle	White	Yellow	Red																				
0.2	0	279	167	70																						
0.2	+20	112	67	28																						
0.2	-20	112	67	28																						
IRC 35:2015; Section 800 of MORTH	On Site Testing	Skid Resistance	Not less than 45 BPN (British Pendulum Number) as per BS:6044	Every 1 km for each color																						

Item No. – 83

Flexible Median Marker : Providing and Fixing of Flexible Median Marker that are made of tough, high impact resistant, injection-molded, thermoplastic body with property of flexibility to provide high durability. The dimension of Flexible Median Marker should not exceed 18.4 cm in height(including shank height), 12.5 Cm in width, .0.65 cm in thickness and shank depth shall be 3.4 cm The body structure shall be rounded at all its corners and edges. The plastic used for molding the Flexible Median Marker should survive impact load of 5kg continuously for 750 times at room temperature. The logo of the manufacturer shall be embossed on either side of the body in the injection molding process. The Median Marker shall have flame like shaped body with, fluorescent yellow color retro-reflective sheeting of size not less than 90 Cm square, with fully reflective micro prismatic cube corners as its retro-reflective elements as per IRC 67 2012 and ASTM D4956-09 type XI specifications reflectivity values. The retro-reflective sheeting shall be one or both sides of the Flexible Median Marker and shall be edge protected with no exposed edges which will prevent edge lifting, vandalism, sheeting damage, etc. The Flexible Median Marker shall be fixed by a combination of epoxy adhesive and grouting as recommended by manufacturer and Engineer in charge.

MEDIAN MARKER

Flexible Median Marker (FMM) should be used for improving median visibility during dark hours. Use of Median Marker provides safety against collision happening with medians during night time or severe weather. Flexible Median Markers shall be provided with fluorescent yellow colour retro reflective sheeting Type XI as per IRC:67. Flexible Median Marker shall be of tough, high impact resistant, injection-molded, thermoplastic body with property of flexibility to provide high durability and U shape structure having rebound/bounce back property. As mentioned earlier, the sheeting shall be of Type XI conforming to IRC:67 and it should be on both the faces whereby providing maximum reflectivity at longer distances with adequate durability. The logo of the manufacturer shall be embossed on either side of the body during the injection molding process. FMM shall be fixed by a combination of epoxy adhesive and grouting/ drilling on concrete medians or properly constructed solid medians.

A. Colour

The marker body shall be produced in neutral Black colour. The colour of the retro reflective element shall be Florescent Yellow.

B. Material

The plastic body of the FMM shall be moulded from Flexible Thermoplastic Body.

C. Dimensions

Height: The marker height shall be a minimum of 180 mm.

Width: The marker width shall be a minimum 120 mm.

Body Thickness: Minimum of 6.5 mm.

Shank Length: Each of the shanks shall not be less than 20 mm and depth shall not be less than 30 mm.

Reflective Area: Shall not be less than 90 cm square.

D. Performance**Reboundability**

The body of FMM shall bounce back to its original position after 750 numbers of hits using pendulum of 1.8 kg conforming to ASTM D 256.

Tensile Test

Adhesion between the body and outer casing body of FMM shall withstand 50 Kgf tensile loads conforming to ASTM D 638 method.

Application and placement

FMM shall be used for the illumination of median as well as Parapet wall structures etc.

Recommended minimum application distance is 2 m in the case of urban areas, 5 m for interurban highways and expressways or as suggested by Engineer In-charge.

Item No. – 84

AFP (Aluminum Backed Flexible Prismatic): Providing and fixing Aluminum backed flexible prismatic sheeting , consisting of yellow/black colored flexible prismatic sheet with non-mettalic prismatic lens as retro reflective elements and conforming to ASTM D4946 Type VI specifications for reboundable retro reflective sheeting. This flexible prismatic sheeting shall be of 30cm width and laminated at the back with a 50 micron Aluminum (Al) foil with pressure sensitive adhesive and liner. Further, this flexible prismatic sheeting shall have screen printed arrow/slant line pattern in black color in a continuous roll format. The AFP sheeting, with the liner removed, shall be applied with a neoprene contact adhesive with a Polychloroprene as base, viscosity of 200-450 cps and solid content of 20-30%. Once applied, the edges of the product shall be sealed all around with a two-part epoxy based structural adhesive and shall be extremely resistant to peel-off. A test report from institutes like ARAI/CRRRI confirming to above mentioned flexibility and ASTM-D4956-09 Type-VI retroreflectivity performance of the flexible prismatic sheeting used in AFP shall be submitted as directed by Engineer-In-Charge.

ASTM D4956 – “Standard Specification for Retroreflective Sheeting for Traffic Control” defines a range of retroreflective sheeting types (Types I through XI) and backing classes. The standard covers flexible microprismatic and glass bead sheeting intended for traffic signs, delineators, roll-up signs, barricades, and similar devices. It does not cover inks, overlays, or finished device performance — only the sheeting material itself.

Type VI sheeting is specifically identified as flexible, high-intensity retroreflective material, typically vinyl or elastomeric and without a permanent factory adhesive (used on self-supporting or temporary products such as roll-up signs, cone collars, bands, portable devices)

Type Definition

- Type VI — Flexible, high-intensity retroreflective sheeting used for roll-up signs, cone collars, post bands, and other temporary/portable devices.
- It is typically vinyl microprismatic sheeting that retains flexibility under repeated bending/folding.

Retroreflective Performance

ASTM D4956 defines minimum retroreflection requirements (R_s) for each Type at specified observation and entrance angles (e.g., 0.2° obs / -4° ent). These requirements vary by color and type. For Type VI specifically, typical minimum coefficient of retroreflection values from earlier specifications are:

•	At	0.2°	obs	/	-4°	ent:	~160	cd·lx ⁻¹ ·m ⁻²
•	At	0.5°	obs	/	-4°	ent:	~100	cd·lx ⁻¹ ·m ⁻²
•	At	0.2°	obs	/	+30°	ent:	~100	cd·lx ⁻¹ ·m ⁻²
•	At	0.5°	obs	/	+30°	ent:	~40	cd·lx ⁻¹ ·m ⁻²

(These values are illustrative from federated spec excerpts for Type VI prismatic materials and are representative of the intent in ASTM D4956-type criteria.)

Backing / Adhesive Class

ASTM D4956 groups sheeting into five backing classes that describe how the sheeting adheres or mounts:

Class	Description
Class 1	Pressure-sensitive adhesive
Class 2	Heat-activated adhesive
Class 3	Removable adhesive
Class 4	Low-temperature pressure-sensitive
Class 5	Fabric or non-adhesive backing (flexible use)

- Type VI sheetings typically use Class 5 backing, meaning flexible, non-adhesive (fabric or support backing) intended to be applied to flexible sign materials or used without permanent base adhesive.

Color & Day/Night Performance

ASTM D4956 also includes daytime luminance factor and chromaticity requirements so that colors (white, yellow, orange, etc.) meet visibility expectations under daylight and reflective conditions. These measurements ensure the sheeting not only *reflects* but *appears correctly colored* in both day/night conditions

Durability Requirements

Although D4956 itself does *not* mandate in-service performance requirements, it specifies outdoor weathering and accelerated weathering testing for retroreflective sheeting that ensure material integrity under environmental exposure (no cracking, delamination, blistering) and retention of retroreflectivity.

Aluminum-Backed Flexible Prismatic Sheets

ASTM D4956 does not mandate an aluminum backing for Type VI flexible materials — Type VI is generally non-adhesive, flexible vinyl. However:

- Some specifications (e.g., agency/transportation department contracts) may extend ASTM D4956 performance criteria to aluminum-backed flexible prismatic films intended to be bonded to aluminum panels or sign blanks.
- In such cases, the retroreflective sheet meets D4956 Type VI photometric and durability criteria, while the backing (e.g., aluminum sheet) and bonding method (adhesive or heat activation) are defined in the procuring specification itself (e.g., state DOT specs).

This means ASTM D4956 provides the sheeting performance “envelope”, but the actual aluminum backing requirements (thickness, alloy, bending characteristics, adhesive interface) must be defined by project specifications outside the ASTM D4956 document.

Standard Delineator: Providing and fixing of Standard Metal Delineator consisting of minimum retro reflective unit exposed area of 330 cm² white color, full cube corner micro prismatic non-metallic retro reflective sheeting on each side conforming with IRC 67 2012 and meeting the coefficient of retro reflection values as per ASTM D 4956 Type XI table specification. The delineator shall be painted with powder coat of minimum 40 microns thickness, on top of which retro reflective sheeting shall be pasted on both sides. The structure shall be manufactured in roll forming process and shall have height not less than 800 mm above the ground, width not less than 100 mm and shall extend not more than 300mm below the ground while being installed. height of sheeting should be minimum 150mm whereas width of sheeting should not be less than 75mm (should be placed every alternative 15cm). The front and back faces of the delineator should be curved with a radius of not more than 200 mm and with delta angle (or central angle of curve) lying between 20o and 30o, to increase the visibility of the delineator for vehicles moving in continuous curves. The delineator shall have grooves across the length to make the reflective sheetsvandal-proof. The delineator is meant for application on gaps in median, traffic islands, dangerous bends, roundabouts, narrow bridges etc. or as desired by site engineer

ROADWAY INDICATORS

Design

Roadway indicators are popularly called as Delineators or Guide Poles. It is basically a form of guide posts made of Mild steel with pure polyester powder coating with the minimum thickness of powder coating of not less than 40 micron for protection against corrosion. The surface should be concealed so that there should not be any exposed surface without powder coating. Alternatively, these metal guide poles can be concealed with thermoplastic body which is of course somewhat cost prohibitive. The posts shall have an ellipsoidal or circular design with the height of the pole shall be 800 to 900 mm above the ground with about 200 to 300 mm base which can be anchored onto the ground. Mild steel Guide Poles shall conform to Type XI sheeting specifications as per IRC:67 and ASTM D 4956 which would ensure to obtain clear visibility of the road alignment during night time (refer Fig. 1). In this context, to achieve enhanced visibility of the curved portion of the road, guide poles shall have substantial area allocated to exhibit alternate band of black paint and white retro reflective sheeting which can provide added aesthetics as well. The above arrangement shall be in place on both sides of poles in the case of undivided carriageways having sharp curves.

To prevent complete vandalism of the above, it is recommended to house the sheeting coupled with concealed edges as shown in Fig. 1. The normal spacing between two successive guide poles shall be about 50 to 70 m center to

center in case of high speed interurban roads catering to high volume traffic. However, in the case of low volume roads as well as rural roads located on rolling and hilly terrain, concrete delineators (shown in Fig. 2) can be used as these would be less costly.

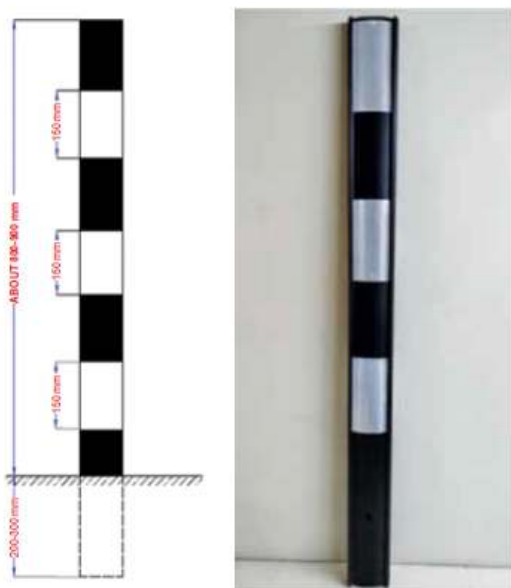


Fig. 1 Typical View of Delineators

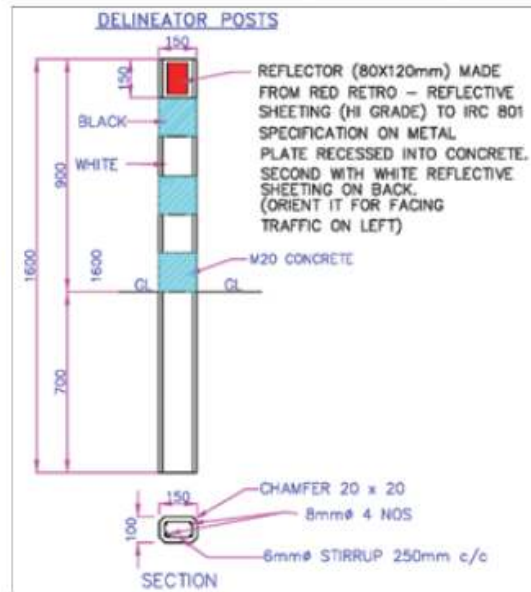


Fig. 2 Typical View of Concrete Delineators

As an alternative to guide poles in work zones, plastic drums with alternative red and white retro-reflective stripes of 100 to 150 mm wide conforming to Type IV Standards (Reboundable work zone sheeting as per ASTM D 4956 Clause S2) shall be used for roadway delineation as shown in Fig. 3, especially when it is for temporary purpose in the event of diversions, road works etc.

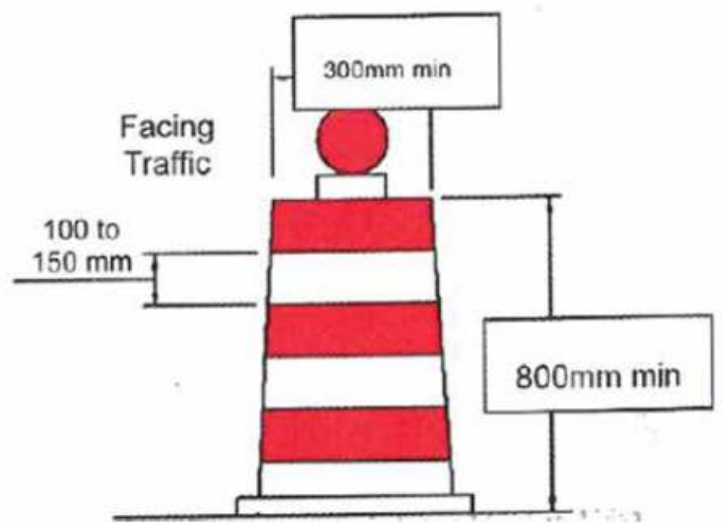


Fig. 3 Temporary Delineator Posts for Work Zones

These temporary guide posts shall possess a height of about 800 to 900 mm above the ground with about 200 to 300 mm base anchored onto the ground. Such temporary delineators shall have three stripes of retro reflective sheeting (each stripe with 150 sq cm or above) of Type XI conforming to IRC:67 and ASTM D-4956 which would ensure clear visibility during night time as shown in **Fig. 3**.

These guide poles shall be always retro reflective in nature as it helps to improve visibility at night and at locations where visibility is poor due to fog etc. As mentioned earlier, the posts should have alternate band of black

colour paint and white retro reflective sheeting of Type XI as per IRC:67 and ASTM D-4956. White colored retro reflective sheeting should be fixed on reverse side of posts in the case of undivided carriageways having sharp curves.

Application

The decision to use roadway indicators, whether continuously or in short sections selectively, will be guided by factors such as importance of the road, quantum of fast traffic, speed of travel, road crash records, danger posed by any specific deficiency in the road alignment, etc. The primary use of roadway indicators in non-urban sections of main roads is especially in curved reaches. However, in the urban stretches, the use of delineators could be decided based on warrants of the road and traffic conditions including the road stretches which are not adequately lighted.

In situations where a guard-rail or parapet wall is provided for safety, roadway indicators shall be mounted above or immediately behind the guard-rail. In addition, the guard-rail shall be treated with Retro-reflective sheeting of Type VI black and yellow stripes with Aluminum backed flexible prismatic sheeting conforming to ASTM D4956-09 which is applicable for reboundable devices.

Criteria for Use

Normally, use of roadway indicators should be considered under the following situations:

- (i) Curved Sections
 - (a) Horizontal curves of radius 300 m or less.
 - (b) Vertical curves with inadequate visibility.
- (ii) Straight Sections
 - a. Road sections where visibility is often poor due to mist, fog or snowy conditions
 - b. Reaches where the alignment appears uncertain to the driver, e.g. pavement width transitions, temporary road diversions, etc.
 - c. Road sections subject to frequent submergence and ponding due to storm water
 - d. Approaches to narrow bridges and culverts
 - e. Valley side of hill roads
 - f. Road embankment exceeding 3 m in height
 - g. Approaches to important intersections
 - h. Special problem points such as causeways and tunnels.

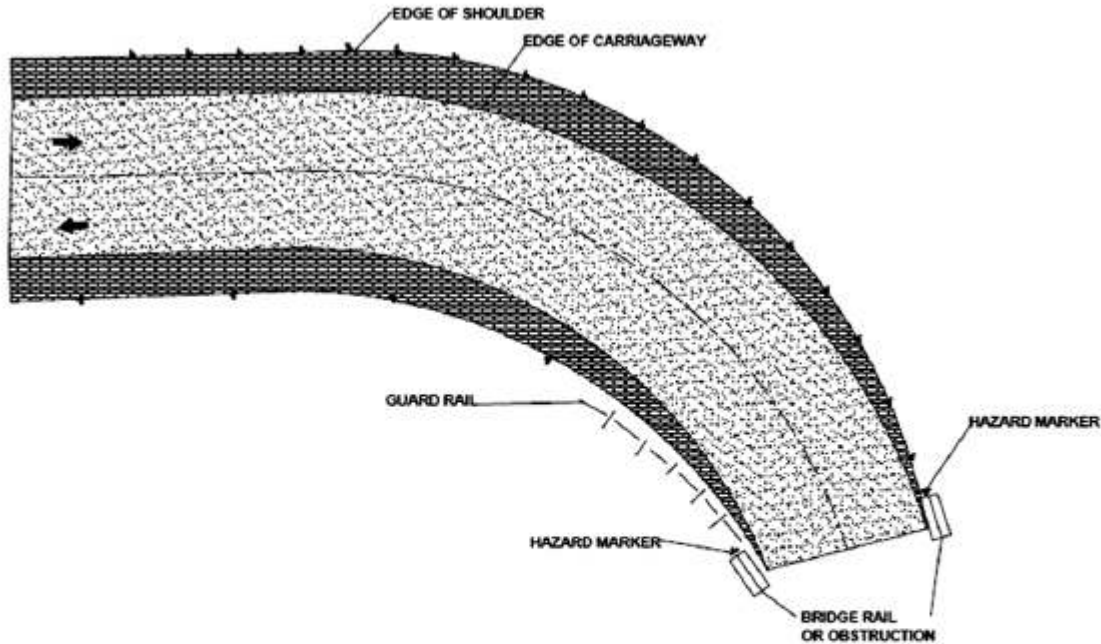
Placement and Spacing

As a general rule, roadway indicators should be erected at the edge of the usable shoulder and in the case of kerbed sections at a distance of 0.6 m from the kerb face. On hilly terrains, they may be placed either on the parapet or at the edge of the earthen shoulder depending on the available roadway width and Right of Way (RoW).

The overall line of posts should be parallel to centre line of the road ordinarily, except that at guard-rails or other obstructions, it may be so adjusted that the delineators are in line with or inside the innermost edge of the obstruction. As far as practicable, the top of the posts should be in uniform grade, taking into account the effects of shoulder cross fall and super elevation.

On straight sections, roadway indicators should be spaced uniformly 50-70 m from each other, according to local conditions, the posts being in pairs, one on each side of the roadway. On divided roads, these should also be provided on medians to meet the condition of providing them on inside of the horizontal curves. Where the normal uniform spacing is affected by cross-roads, driveways etc. and a delineator would fall in that area; the same may be

moved in either direction a distance not exceeding one quarter of the usual spacing. If it still falls in such a zone, it should be omitted.



Delineators mounted above or immediately behind Guard Rail. The placement of delineators are not at constant distance from roadway edge because of the Bridge Rail

Note:-

Delineators should be placed at a constant distance from the carriageway edge except that when an obstruction exists near the pavement edge, the line of delineators should make a smooth transition so as to be in line with the obstruction.

Illustration of Roadway Indicator Installation on the Curved Approach to a Bridge

On horizontal curves, the spacing should be fixed in relation to the curve radius as given in Table 1. In addition, some delineators should be continued beyond the curve on either side. The spacing of first, second and third roadway indicators on the approaches, in advance and beyond the curve, should be 1.8 S, 3 S and 6 S respectively (where S is the normal spacing on the curve) but not exceeding 50 m. The method of placement is explained in Fig.

Table 1 Recommended Spacing for Roadway Indicators on Horizontal Curves

Radius of Curve (meters)	Spacing on Curve, (S) (meters)
30	6
50	8
100	12
200	20
300	25

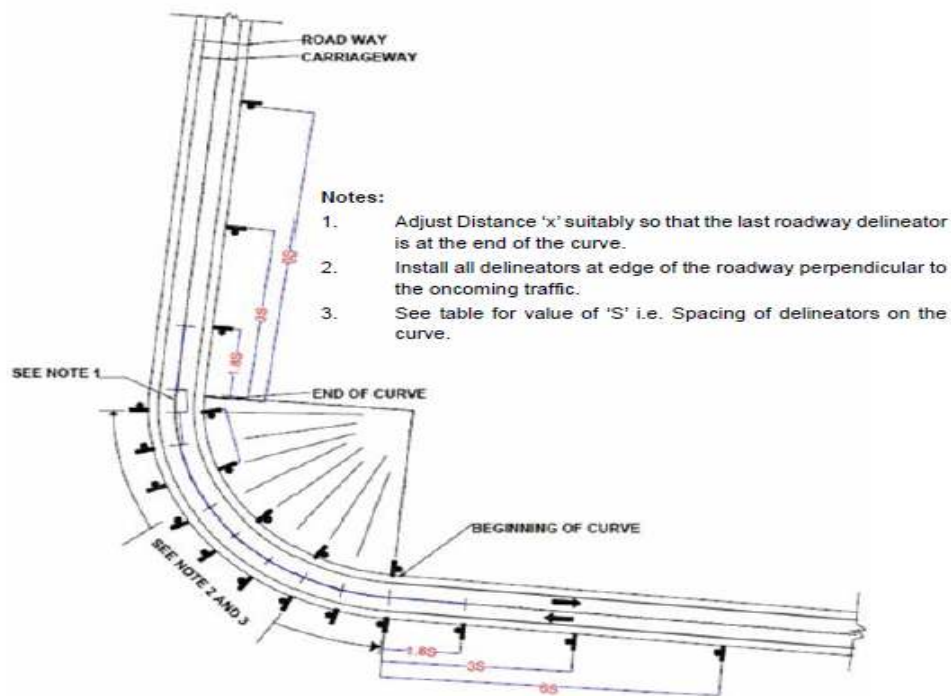


Fig. 6 Typical Illustration of Delineator Spacing on Horizontal Curves

On vertical curves where visibility is not adequate, roadway indicators should be provided at a spacing of 30 to 50 m depending on the sharpness of the curve.

At problematic locations like causeways, road delineators may be installed at a much smaller spacing, say 5 or 10 m, according to local conditions.

Item No. – 86

Solar Stud: Supplying of Solar Raised Pavement Markers made of polycarbonate molded body with circular shape, solar powered, LED self illumination in active mode, 360 degree illumination and reflective panels with micro prismatic lens capable of providing total internal reflection of the light entering the lens face in passive mode. The marker shall support a load of 20000 kg tested in accordance to ASTM D 4280. The marker should be resistant to dust and water ingress according to IP 65 standards and should withstand temperatures in the range of 0 C to 70 C. Color of lighting could be provided in red or yellow (amber) as per requirement and typical frequency of blinking is 1 Hz. There should be current losses of less than 20 micro-amperes at 2.4 V in sleep-charging mode to enhance the life of the marker and a full charge should provide for a minimum autonomy of 50 hours. The height, width and length of the marker shall not be less than 10 mm x 100 mm x 100 mm. Also, the surface diameter of the marker shall not be less than 100 mm respectively. The weight of the marker shall not exceed 0.5 Kilograms. Fixing will be by drilling holes on the road for the shanks to go inside, without nails and using epoxy resin based adhesive as per manufacturers recommendation and complete as directed by the engineer

804.1 Scope

The work shall cover the providing and fixing of reflective pavement marker (RPM) or road stud, a device which is bonded to or anchored within the road surface, for lane marking and delineation for night-time visibility, as specified in the Contract.

804.2 Material

804.2.1 Plastic body of RPM/road stud shall be moulded from ASA (Acrylic Styrene Acrylonitrile) or HIPS (Hi-impact Polystyrene) or Acrylonitrile Butadiene Styrene (ABS) or any other suitable material approved by the Engineer. The markers shall support a load of 13,635 kg tested in accordance with ASTM D 4280.

804.2.2 Reflective panels shall consist of number of lenses containing single or dual prismatic cubes capable of providing total internal reflection of the light entering the lens face. Lenses shall be moulded of methyl methacrylate conforming to ASTM D 788 or equivalent.

804.3 Design

The slope or retro-reflecting surface shall preferably be $35 \pm 5^\circ$ to base and the area of each retro-reflecting surface shall not be less than 13.0 sq.cm.

804.4 Optical Performance

804.4.1 Unidirectional and Bi-directional Studs

Each reflector or combination of reflectors on each face of the stud shall have a Coefficient of Luminous Intensity (C.I.L.) not less than that given in Tables 800-13 or 800-14 as appropriate.

804.4.2 Omni-directional Studs

Each Omni-directional stud shall have a C.I.L. of not less than 2 mcd/lx.

Table 800-13 : Minimum C.I.L. Values for Category 'A' Studs

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 5° L & R	0.3°	220	110	44
0° U 10° L & R	0.5°	120	60	24

Table 800-14 : Minimum C.I.L. Values for Category 'B' Studs

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 6° L & R	0.3°	20	10	4
0° U 10° L & R	0.5°	15	7.5	3

Note:

1. The entrance angle of 0° U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.
2. The stud incorporating one or more corner cube reflectors shall be included in Category 'A'. The stud incorporating one or more bi-convex reflectors shall be included in Category 'B'.

804.5 Tests

804.5.1 Co-efficient of luminance intensity can be measured by procedure described in ASTM E 809 "Practice for Measuring Photometric Characteristics" or as recommended in BS:873-Part 4: 1973.

804.5.2 Under test conditions, a stud shall not be considered to fail the photometric requirements if the measured C.I.L. at any one position of measurement is less than the values specified in Tables 800-13 or 800-14 provided that

- i) the value is not less than 80 percent of the specified minimum, and
- ii) the average of the left and right measurements for the specific angle is greater than the specified minimum.

804.6 Solar Powered Road Markers (Solar Studs)

The solar studs shall be made of Aluminium alloy and poly carbonate material which shall be absolutely weather resistant and strong enough to support a load of 13,635 kg tested in accordance with ASTM D4280. Its colour may be white, red, yellow, green or blue or combination as directed by the Engineer. Its water resistance shall meet the requirements of IP 65 in accordance with IS:12063:1987 Category 2 for protection against water ingress. The dimensions of solar studs shall not be less than 100 mm x 100 mm x 10 mm. It shall have super bright LEDs so as to provide long visibility from a distance of more than 800 m. Its flashing rate shall not be less than 1 Hz. Its should be able to give the prescribed performance in the temperature range of -40°C to +55°C. Its life shall be not less than 3 years.

804.7 Fixing of Reflective Markers 804.7.1 Requirements

The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic. The reflecting portions of the studs shall be free from crevices shall not exceed 20 mm. and its width shall not exceed 130 mm. The base of the marker shall be flat within 1.3 mm. If the bottom of the marker is configured, the outermost faces of the configurations shall not deviate more than 1.3 mm from a flat surface. All road studs shall be legibly marked with the name, trade mark or other means of identification of the manufacturer.

804.7.2 Placement

The reflective marker shall be fixed to the road surface using the adhesives and the procedure recommended by the manufacturer. No nails shall be used to affix the marker so that they do not pose safety hazard on the roads. Regardless of the type of adhesive used, the markers shall not be fixed if the pavement is not surface dry and on new asphalt concrete surfacing until the surfacing has been opened to traffic for a period of not less than 14 hours. The portions of the highway surface, to which the marker is to be bonded by the adhesive, shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the of the marker in a quantity sufficient to result in complete coverage of the area of contract of the marker with no voids present and with a slight excess after the marker has been lightly pressed in place. For epoxy installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed.

804.7.3 Warranty and Durability

The contractor shall submit a two year warranty for satisfactory field performance including stipulated retro-reflectance of the reflecting panel, to the Engineer. In addition, a two year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carries out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or lose their reflectivity compared to stipulated standards, the contractor would be required to replace all such markers within 15 days of the intimation from the Engineer, at his own cost.

804.8 Measurement for Payment

The measurement of reflective road markers/solar powered road studs shall be in numbers of different types of markers supplied and fixed.

804.9 Rate

The contract unit rate for reflective road markers/solar powered road studs shall be payment in full compensation for furnishing all labour, material, tools, equipment including incidental costs necessary for carrying out the work at site conforming to the specification complete as per approved drawings or as directed by the Engineer.

Providing and laying of Plastirib - T or equivalent raised profile edge line marking (audible warning) with hot applied thermoplastic road marking compound according to IRC 35 - 2015, Clause 7.7, with 2mm thick base coat layer above that ribs profile size of length 40mm X width 140mm X Height 6 mm thick (Total 8 mm thick) at the distance of 250 mm between two ribs including reflectorizing glass beads @ 250 gm/ sq.mt area. The maximum width of raised profile should be 150 mm. The thickness of 8 mm profile should be exclusive of surface applied glass beads. The finished surface to be levelled, uniform and free from streaks and holes, to be applied on edge lines. The profile marking should be mark basic line and raise line at a time simultaneously.

7.7 Raised Profile Edge Lines

7.7.1 Raised profile edge lines are for use as an alternative to the edge markings. It is a continuous line marking with ribs across the line at regular intervals. The advantage of ribs is that the vertical edges of the raised ribs are clearly visible above the water film in wet conditions. The other advantage of raised ribs is that they provide audible warning to drivers when vehicle pass over the ribs and produce audible vibrations as warning. The type and pattern of raised profile lines are shown in **Fig. 7.4**.

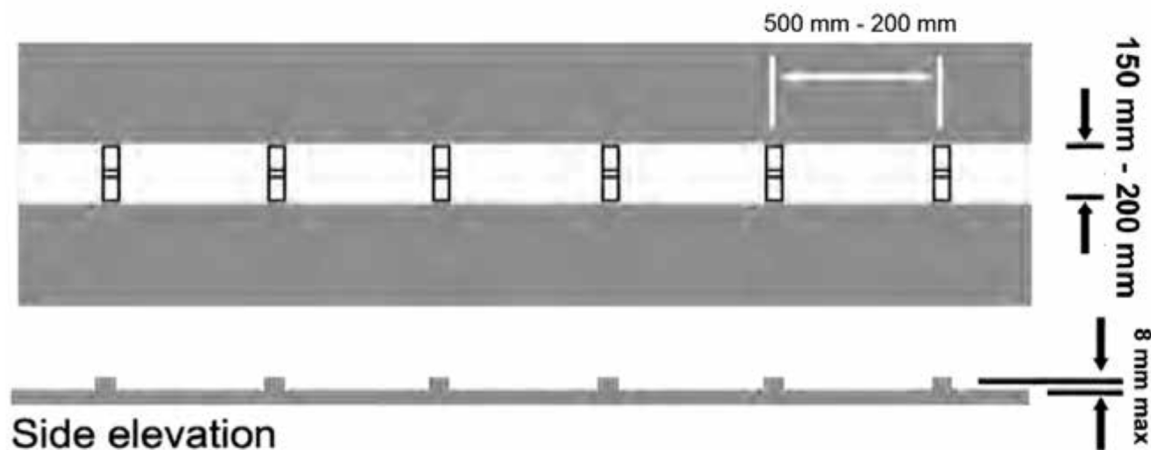


Fig. 7.4 Raised Profile Edge Lines

7.7.2 In general, spacing between two ribs should not exceed 500 mm. However, for expressway the recommended spacing between two ribs is 250 mm. Closely Spaced Ribs helps in maintaining rumble effect; but at the same time, it can become hazardous to the cyclist. The minimum and maximum width of raised profile edge should be 150 mm and 200 mm as shown in HM26/HM27/HM28 in **Table A.3 of Annexure A** and height generally vary from 4 mm to 8 mm, whereas in the case of expressway it can be up to a maximum of 11 mm. Raised profile markings should be discontinued when edge line passes through crossway meant for pedestrian and cyclist.

7.7.3 On the curved roads, having radii less than 1000 m, raised edge line should not be provided as the ribs of the raised edge line markings will destabilize two wheelers. To facilitate drainage, a gap of 100 mm to 150 mm should be provided at an interval of around 36 m; otherwise rain water may get collected on the road surface.

Item No. – 92

Type - A, "W" : Metal Beam Crash Barrier (Providing and erecting a "W" metal beam crash barrier comprising of 3 mm thick corrugated sheet metal beam rail, 70 cm above road/ground level, fixed on ISMC series channel vertical post, 150 x 75 x 5 mm spaced 2 m centre to centre, 1.8 m high, 1.1 m below ground/road level, all steel parts and fitments to be

galvanised by hot dip process, all fittings to conform to IS:1367 and IS:1364, metal beam rail to be fixed on the vertical post with a spacer of channel section 150 x 75 x 5 mm, 330 mm long complete as per clause 811)

811.3 Metal Beam Crash Barrier

811.3.1 Materials

811.3.1.1 Metal beam rail shall be corrugated sheet steel beams of the class, type, section and thickness indicated on the drawings. Railing posts shall be made of steel of the section, weight and length as shown on the drawings. All complete steel rail elements, terminal sections, posts, bolts, nuts, hardware and other steel fittings shall be galvanized. All elements of the railing shall be free from abrasions, rough or sharp edges and shall not be kinked, twisted or bent.

811.3.1.2 The "W" beam type safety barrier shall consist of a steel post and a 3 mm thick "W" beam rail element. The steel post and the blocking out spacer shall both be channel section of 75 mm x 150 mm & size 5 mm thick. The rail shall be 70 cm above the ground level and posts shall be spaced 2 m center-to-center. Double "W" beam barrier shall be as indicated in IRC:5-1998.

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.

The "W" beam, the thrie beam, the posts, spacers and fasteners for steel barriers shall be galvanized by hot dip process (zinc coated, 0.55 kg per square metre; minimum single spot) unless otherwise specified. The galvanizing on all other steel parts shall conform to the relevant IS Specifications. All fittings (bolts, nuts, washers) shall conform to the IS: 1367 and IS:1364. All galvanizing shall be done after fabrication.

811.3.1.3 Concrete for bedding and anchor assembly shall conform to Section 1700 of these Specifications.

811.3.2 Construction Operations

811.3.2.1 The line and grade of railing shall be true to that shown on the plans. The railing shall be carefully adjusted prior to fixing in place, to ensure proper matching at abutting joints and correct alignment and camber throughout their length. Holes for field connections shall be drilled with the railing in place in the structure at proper grade and alignment.

811.3.2.2 Unless otherwise specified on the drawing, railing steel posts shall be given one shop coat of paint (primer) and three coats of paint on structural steel after erection, if the sections are not galvanized. Any part of assembly below ground shall be painted with three coats of red lead paint.

811.3.2.3 Splices and end connections shall be of the type and designs specified or shown on the plans and shall be of such strength as to develop full design strength of the rail elements.

811.3.3 Installation of Posts

811.3.3.1 Holes shall be dug or drilled to the depth indicated on the plans or posts may be driven by approved methods and equipment, provided these are erected in proper position and are free from distortion and burring or any other damage.

811.3.3.2 All post holes that are dug or drilled shall be of such size as will permit proper setting of the posts and allow sufficient room for backfilling and tapping.

811.3.3.3 Holes shall be backfilled with selected earth or stable materials in layers not exceeding 100 mm thickness and each layer shall be thoroughly tamped and rammed. When backfilling and tamping *are* completed, the posts or anchors shall be held securely in place.

811.3.3.4 Post holes that are drilled in rock and holes for anchor posts shall be backfilled with concrete.

811.3.3.5 Posts for metal beam guardrail on bridges shall be bolted to the structure as detailed on the plans. The anchor bolts shall be set to proper location and elevation with templates and carefully checked.

811.3.4 Erection

811.3.4.1 All guard rail anchors shall be set and attachments made and placed as indicated on the plans or as directed by the Engineer.

811.3.4.2 All bolts or clips used for fastening the guardrail or fittings to the posts shall be drawn up tightly. Each bolt shall have sufficient length to extend at least 6 mm through and beyond the full nut, except where such extensions might interfere with or endanger traffic in which case the bolts shall be cut off flush with the nut.

811.3.4.3 . All railings shall be erected, drawn and adjusted so that the longitudinal tension will be uniform throughout the entire length of the rail.

811.3.5 End Treatment for Steel Barrier

811.3.5.1 End treatments shall form an integral part of safety barriers which 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", as shown on the drawings or as directed by the Engineer.

811.3.6 Tolerance

The posts shall be vertical with a tolerance not exceeding 6 mm in a length of 3 m. The railing barrier shall be erected true to line and grade.

811.3.7 Measurements for Payment

811.3.7.1 Metal beam railing barriers will be measured by linear metre of completed length as per plans and accepted in place. Terminals/anchors of various types shall be paid for by numbers.

811.3.7.2 Furnishing and placing anchor bolts and/or devices for guard rail posts on bridges shall be considered incidental to the construction and the costs thereof shall be included in the price for other items of construction.

811.3.7.3 No measurement for payment will be made for excavation or backfilling performed in connection with this construction.

811.3.8 Rate

The Contract unit rate shall include full compensation for furnishing of labour, materials, tools, equipments and incidental costs necessary for doing all the work involved in constructing the metal beam railing barrier complete in place in all respects as per these Specifications.

Item No. – 93

Providing and erecting a Road Restraint System -Roller System Barrier ETI Roller System H1 & H2 comprising of post of hot dip galvanized steel of 139.8 mm diameter (L-2200 and L-750) thickness 4.5 mm spaced with interval of 1 meter installed into hardened road. Safet frame rail from sheet of 3.2 mm thick are fixed to main posts, shock absorbing rallers 345 mm diameter and 430 mm height made of polypropylene - EVA, post caps, locker pipes and connection material. Distance between main past and short post shall be 500 mm and the height of upper edge rail is 960 mm. All steel parts (FRAME S235JR equivalent SS400)| and post S235JR shall be hot dip galvanized against corrosion. The system shall be installed after Road Safety Survey, Liasoning for reports, Pre & Post Assessment & Installation report in accordance with the design & drawings and assembly instructions etc. complete

1. Scope of Work

This work shall consist of providing, supplying, erecting, testing, and commissioning of Road Restraint System – Roller System Barrier (ETI Roller System) conforming to H1 and H2 containment levels, complete with hot dip galvanized steel posts, safety frame rails, shock absorbing rollers, accessories, surveys, liaisoning, and documentation, all in accordance with IRC guidelines, approved drawings, and manufacturer's assembly instructions, complete in all respects.

2. Applicable Codes and Standards

The Roller System Barrier shall conform to the latest editions of:

- IRC:119 – Guidelines for Road Restraint Systems
- EN 1317 (Parts 1–5) – Road restraint systems (Containment level H1 & H2)

- IS 2062 / EN 10025 (S235JR) – Structural steel
- IS 4759 / IS 2629 – Hot Dip Galvanizing
- IRC:67 – Road Signs and Retro-reflective Devices

In case of any discrepancy, IRC provisions shall prevail.

3. Containment Level and Performance

- Containment Class: H1 & H2
- Crash Test Standard: EN 1317
- Vehicle Redirection: Safe redirection without rollover
- Impact Severity: ASI Class A or B
- Working Width: As per approved crash test report

The system shall be fully crash-tested and certified by an internationally accredited laboratory.

4. System Configuration and Geometry

Parameter	Requirement
Post Spacing	1.0 m (centre to centre)
Main Post Diameter	139.8 mm
Post Thickness	4.5 mm
Main Post Length	2200 mm
Short Post Length	750 mm
Distance between Main & Short Post	500 mm
Height of Upper Edge Rail	960 mm
Roller Diameter	345 mm
Roller Height	430 mm

5. Materials and Components

5.1 Steel Posts

- Posts shall be made of hot-rolled structural steel S235JR (equivalent to SS400).
- Diameter: 139.8 mm
- Thickness: 4.5 mm
- Posts shall be installed into hardened road / concrete foundation as per approved design.
- All posts shall be hot dip galvanized after fabrication.

5.2 Safety Frame Rails

- Safety frame rails shall be manufactured from 3.2 mm thick steel sheet.
- Steel grade: S235JR / SS400.
- Rails shall be securely fixed to the main posts to support the roller units.
- Rails shall be designed to transfer impact loads safely to the posts.

5.3 Shock Absorbing Rollers (Rallers)

- Rollers shall be made of high-impact polypropylene–EVA (Ethylene Vinyl Acetate).
- Roller dimensions:
 - Diameter: 345 mm
 - Height: 430 mm

- Rollers shall be energy absorbing, UV stabilized, weather resistant, and capable of repeated impacts without cracking.
- Rollers shall be provided in high visibility colour with reflective bands.

5.4 Accessories

The system shall include:

- Post caps
- Locker pipes
- Connection materials
- Bolts, nuts, washers (high tensile, galvanized)

All accessories shall be compatible with the tested system configuration.

6. Corrosion Protection

- All steel components including posts, rails, frames, locker pipes, fasteners shall be hot dip galvanized in accordance with IS 4759 / IS 2629.
- Minimum zinc coating: 610 g/m².
- No uncoated steel surfaces shall be permitted.

7. Installation Requirements

- Installation shall be carried out strictly as per approved design drawings, EN 1317 crash-tested configuration, and manufacturer's assembly instructions.
- Posts shall be accurately aligned, plumbed, and fixed before tightening.
- Rollers and rails shall be installed ensuring free rotation of rollers.
- Any deviation from approved configuration shall require Engineer's approval.

8. Road Safety Survey & Documentation

The system shall be installed only after completion of the following by the contractor:

- Road Safety Survey
- Liaisoning with authorities for approvals and reports
- Pre-installation safety assessment
- Post-installation safety assessment
- Installation completion report
- As-built drawings

All reports shall be submitted and approved prior to final acceptance.

9. Quality Control and Acceptance

The contractor shall submit:

- EN 1317 crash test certificates (H1 & H2)
- Material test certificates for steel and rollers
- Galvanization test reports

Inspection shall include:

- Dimensional accuracy
- Proper spacing and alignment
- Integrity of rollers and rails
- Galvanization quality

Defective or damaged components shall be replaced at no extra cost.

10. Measurement

Measurement shall be made in running metres (RM) of Roller System Barrier installed and accepted, including all posts, rollers, rails, accessories, surveys, and documentation.

11. Rate

The rate shall include:

- Design, supply, and fabrication
- Galvanization of all steel components
- Shock absorbing rollers and accessories
- Road safety survey and liaisoning
- Installation, testing, and commissioning
- Reports, drawings, labour, equipment, and all incidentals

12. Technical Intent (as per IRC:119)

The Roller System Barrier shall:

- Absorb and dissipate impact energy
- Redirect errant vehicles safely
- Reduce severity of crashes
- Improve visibility and roadside safety at hazardous locations

Item No. – 94

Providing and fixing Height Restriction Barrier (HRB) consisting of MS structural steel frame forming portal type gantry across the carriageway, designed to restrict movement of over-height vehicles, having clear height for 2.75m, complete with vertical posts, horizontal cross beam, bracings, base plates, anchor bolts, and foundations in PCC & RCC, fabricated, erected, painted with approved primer and two coats of synthetic enamel paint, provided with retro-reflective sheeting, hazard markings, and height restriction signage conforming to IRC:67, including all materials, labour, tools, traffic safety measures, testing and commissioning, complete as per MoRTH Specifications (Section 800) and relevant IRC guidelines, to the satisfaction of the Engineer-in-Charge. For Clear Width upto 8.0m.

1. Scope of Work

This item covers providing, fabricating, supplying, erecting, and commissioning of portal-type gantry Height Restriction Barriers (HRB) across the carriageway, to restrict over-height vehicles, for clear height of 2.75 m and clear width up to 8.0 m. The work shall include all structural steel, foundations, fasteners, retro-reflective sheeting, hazard markings, signage, painting, and traffic safety measures, complete in accordance with MoRTH Section 800, IRC guidelines, and the directions of the Engineer-in-Charge.

2. Applicable Codes and Standards

- MoRTH Specifications, Section 800 – Road Safety Appurtenances
- IRC:67 – Road Signs and Retro-reflective Sheeting
- IS 2062 – Structural Steel (MS)
- IS 800 – General Construction in Steel
- IS 4759 / IS 2629 – Hot-Dip Galvanizing of Steel
- IS 456 / IS 516 – Concrete and Testing Standards

In case of conflict, IRC/MoRTH provisions shall prevail.

3. Materials

3.1 Structural Steel

- All vertical posts, horizontal cross beams, bracings, and base plates shall be fabricated from MS structural steel (IS 2062, Grade E250).
- All steel surfaces shall be primed with approved primer and painted with two coats of synthetic enamel paint.
- Steel may be hot dip galvanized where specified or as directed by the Engineer.

3.2 Foundations

- Base plates shall be anchored into RCC / PCC foundations designed to safely resist wind loads, lateral vehicle impacts, and self-weight.
- Reinforcement steel for RCC shall conform to IS 1786, and concrete shall be M25 grade.

3.3 Fasteners and Accessories

- Anchor bolts, nuts, and washers shall be high-tensile steel and corrosion-protected.
- All joints shall be rigid and conforming to approved design.

4. Design Requirements

- Clear Height: 2.75 m
- Clear Width: Up to 8.0 m
- Gantry shall be designed to resist:
 - Wind loads (as per IS 875)
 - Impact from over-height vehicles
 - Dead load of structure and attachments
- Adequate bracing shall be provided for stability.
- Portal gantry shall allow unobstructed passage for vehicles within permissible height and width.

5. Signage and Visibility

- HRB shall include:
 - Height restriction signage conforming to IRC:67
 - Retro-reflective sheeting for night visibility
 - Hazard markings / alternating black and yellow stripes
- All markings and signage shall be durable and UV-resistant.

6. Fabrication and Surface Protection

- Steel members shall be cut, welded, and assembled in accordance with approved drawings.
- Surfaces shall be prepared for painting:
 - One coat of primer
 - Two coats of synthetic enamel paint in approved colour
- Retro-reflective materials and hazard markings shall be applied after painting.

7. Erection and Installation

- Gantry shall be installed on prepared PCC / RCC foundations with anchor bolts.
- Verticality, alignment, and level shall be checked before final tightening.
- Erection shall include:

- Placement of vertical posts, horizontal beam, bracings
- Fixing of signage and retro-reflective materials
- Any temporary supports required for stability during construction

8. Traffic Safety

- Adequate traffic safety measures shall be implemented during erection, including:
 - Diversions
 - Safety barricades
 - Flagmen or signals
- Contractor is responsible for safe working and minimal disruption to traffic.

9. Quality Control and Testing

- Steel material certificates shall be submitted.
- Concrete cubes shall be tested as per IS 516.
- Installed HRB shall be inspected for:
 - Structural stability and alignment
 - Proper signage and reflective sheeting
 - Compliance with clear height and width
- Any defective component shall be replaced at no extra cost.

10. Measurement

- Measurement shall be in **number of HRB gantries installed and accepted**, inclusive of all posts, beams, bracings, fasteners, foundations, signage, painting, and accessories.

11. Rate

The rate shall include:

- Supply, fabrication, and painting of structural steel
- PCC / RCC foundations with anchor bolts
- Retro-reflective sheeting and hazard markings
- Height restriction signage
- Erection, testing, and commissioning
- Traffic safety measures, labour, tools, and equipment

12. Technical Intent

The HRB gantry shall:

- Prevent over-height vehicle collisions with overhead structures
- Ensure safe and visible advance warning
- Be durable, corrosion-resistant, and low-maintenance
- Maintain road safety as per IRC and MoRTH standards

Providing & Supplying New Jersey type Precast M25 grade concrete and min 15 kg reinforcement in each crash barrier of size having 0.25 smt cross sectional area and 1.0 m length with lifting provision and making one coat primer and two coats of reflective paints etc complete.

1. Scope of Work

This item covers providing, casting, curing, supplying, and delivering New Jersey type precast reinforced concrete crash barriers, ready for installation. Each barrier shall include lifting provisions, minimum reinforcement, and painted surfaces with reflective coatings, complete with all materials, labour, tools, and accessories as required for a fully functional traffic safety barrier.

2. Applicable Standards

- IRC:119 – Guidelines for Roadside Safety Barriers
- IS 456 – Code of Practice for Plain and Reinforced Concrete
- IS 1786 – High Strength Deformed Steel Bars
- IS 383 – Coarse and Fine Aggregates
- IRC:67 – Retro-reflective Sheeting and Road Markings
- MoRTH Section 800 – Road Safety Appurtenances

In case of conflict, IRC/MoRTH provisions shall prevail.

3. Material Requirements

3.1 Concrete

- Grade: M25
- Cement: Ordinary Portland Cement conforming to IS 269/8112/12269
- Coarse & fine aggregates: As per IS 383
- Water: Clean, potable water
- Admixtures: As approved by the Engineer, if required
- Concrete shall be machine mixed and vibrated for proper compaction.

3.2 Reinforcement

- Minimum 15 kg of mild steel or high strength deformed bars per barrier
- Steel shall conform to IS 1786 / IS 432
- Minimum concrete cover: 40 mm

3.3 Lifting Provisions

- Each barrier shall have integral lifting hooks or sleeves sufficient to safely lift and transport the unit.

4. Geometry

- Cross-sectional area: 0.25 m²
- Length of each unit: 1.0 m
- Shape: Standard New Jersey profile as per IRC:119

5. Casting and Curing

- Barriers shall be precast in approved yard or casting beds with proper steel moulds.
- Concrete shall be vibrated for compaction.
- Demoulding shall be carried out carefully to avoid cracks.

- Curing shall be for minimum 14 days, using water curing or curing compound.

6. Surface Finish

- All exposed surfaces shall be smooth, defect-free, and uniform.
- Minor surface defects shall be repaired with cement mortar before painting.

7. Painting and Reflectivity

- After curing, each barrier shall be treated as follows:
 - One coat of approved concrete primer
 - Two coats of synthetic enamel reflective paint (colour: black & yellow or black & white as approved)
- Reflective paint shall conform to IRC:67 for night visibility.

8. Quality Control

- Material test certificates shall be submitted for cement, aggregates, and steel.
- Concrete cube tests shall be carried out as per IS 516.
- Barriers shall be inspected for:
 - Dimensional accuracy
 - Proper reinforcement and lifting provisions
 - Smooth surface finish
 - Proper painting and reflectivity

Any defective or damaged unit shall be rejected.

9. Measurement

- Measurement shall be in number of precast barriers supplied and accepted.

10. Rate

The rate shall include:

- Design, casting, and curing of precast barrier
- Reinforcement steel (minimum 15 kg/unit)
- Lifting hooks or sleeves
- Primer and reflective paint (two coats)
- Loading, unloading, and stacking
- All labour, tools, and incidentals required for supply

11. Technical Intent

The New Jersey type precast barrier shall:

- Provide positive vehicle containment and median separation
- Reduce the severity of roadside accidents
- Be durable, visible, and easy to install
- Conform to IRC:119 standards

Providing and fixing Flood Gauge sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 430 mm wide and 2000 mm above G.L. marked with scale as per design of IRC-67-2012 (Figur No. 18.10). Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ; reflectorised with High Intensity Prismatic Grade retro reflectivesheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T.Specifications; 430 mm x 2500 mm frame of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required; painted with best quality epoxy coatings in black and white bends. The details of symbol or inscription / numerals for each board shall be as per the instruction of engineer in charge. The fixing at site shall be in 1:2:4 CC block of size 45 x 45 x 60 Cms. for each leg including excavation, curing etc.complete under the supervision of engineer in charge. A warranty for 7 years for the Retro reflective sheeting from original manufacturer & a certified copy of 3 year outdoor exposure test report from third party test lab for the product offered shall be submitted by contractor. (A) Class-B Type-4 Retro Reflective sheeting

As per Separate sheet attached. (MORTH, Section - 801 & IRC-67: 2022)

Item No:- 98

Providing and applying two coats of white washing with lime (chuna) and geru band to roadside trees up to a height of 1.0 m to 1.2 m from ground level, including cleaning the surface, preparing the lime solution with suitable adhesive (fevicol/salt), applying geru band of approved width, and all labour, materials, tools & plants, watering, and incidental charges complete as directed by Engineer-in-Charge.

The work shall include:

- Cleaning the tree surface by removing loose bark, dust, mud, algae and other foreign materials manually to ensure proper adhesion of white wash.
- Preparing lime wash using freshly slaked fat lime conforming to relevant IS specifications, mixed with suitable adhesive such as Fevicol, gum or common salt in approved proportion to improve bonding and durability.
- Applying two uniform coats of white wash evenly over the tree trunk up to specified height, allowing adequate drying time between coats.
- Providing geru (red ochre) band of approved width and height at specified location on the trunk with neat and uniform finish.
- The finished surface shall be smooth, uniform in colour and free from streaks, patches or brush marks.
- The work shall be executed as per CPWD Specifications and directions of Engineer-in-Charge.

The rate shall include cost of all materials, labour, scaffolding if required, tools & plants, preparation of surface, mixing, application, watering, curing, transportation, loading/unloading and all incidental charges complete.

The mode of measurement is in Each/ Nos if finished work.

Item No:- 98

Providing and erecting a Road Restraint System -Roller System Barrier ETI Raller System H1 & H2 comprising of post of hot dip galvanized steel of 139.8 mm diameter (L-2200 and L-750) thickness 4.5 mm spaced with interval of 1 meter installed into hardened road. Safet frame rail from sheet of 3.2 mm thick are fixed to main posts, shock absorbing rallers 345 mm diameter and 430 mm height made of polypropylene - EVA, post caps, locker pipes and connection material. Distance between main past and short post shall be 500 mm and the height of upper edge rail is 960 mm. All steel parts (FRAME S235JR equivalent SS400)] and post S235JR shall be hot dip galvanized against corrosion. The system shall be installed after Road Safety Survey, Liasoning for reports, Pre & Post Assessment & Installation report in accordance with the design & drawings and assembly instructions etc. complete

1.1 Scope

The Road Restraint system - The rolling safety barriers do more than absorb impact energy. They convert impact energy into rotational energy to propel the vehicle forward rather than potentially breaking through an immovable barrier. Design is provided as shown in the Drawing.

1.2 Material

Rolling Safety barrier, type Roller System are longitudinal barrier designed to contain, redirect and shield vehicles from roadside barriers which are consisting from steel posts 139.8 mm (L-2200 mm and L-720 mm) thickness 4.5 mm spaced with an interval of 1 m, installed into hardened roads. The safety frame rails from sheet 3.2 mm thick are fixed to the main posts, Shock absorbing rollers 345 mm and height 480 mm from polypropylene -EVA, Post caps, locker, pipes and connection material as per Drawing. Distance between main posts and short posts are 500 mm.

The height of upper edge of the rail is 960 mm. The bottom and top frame rails were mounted at a height of 13.8 inch (350 mm) and 37.4 inch (850 mm) from steel, respectively. The frame rails were mounted the posts by a support and locker assembly of steel. Each assembly was bolted to the posts with four (4) 19x60 bolts. Standards for bolts and nuts should meet KS B 1002, KS B 1012. The frame rails were 26.2 ft. (8 m) long and the splices were placed mid span between posts. The short posts were 720 mm long and were attached to the frame rail by the same support and locker assembly as the long posts.

All steel parts (frame S235JR (equivalent SS400 or ASTM A36), post S235JR (equivalent STK400 or ASTM A36) are protected against corrosion by hot dip galvanizing. Galvanization of the product that is coated only by zinc galvanizing shall be performed in accordance with the requirements of KSD 8308(Hot dip galvanizing) and KSD 9521 (Work standard for Hot dip galvanizing). The amount of zinc shall be 550g/m or more. Galvanization of the product shall be performed after rust, dust and impurities on all the material surfaces are completely removed.

The system is installed in accordance with the attached drawing and the assembly instructions.

1.3 Installation & Erection

Marking Process

1. Check the road surface to drive posts if any cables or fixtures are buried in.
2. Stand steel sticks strong from start point and end point continually (Make sure the sticks stand at Exact point along the road where the post is erected).
3. Tie up the string at sticks every 5 m and make the string stretched tight until the end and adjusted String to be at the exact from the vehicle road surface.
4. Make sure the string do not come loose.
5. Mark on the string every 1meter that is the point where each long post will be driven.

Driving Post

1. A pile driver with a post holder fixed on the top of arm grab the post at the point of erection.
2. Drive each post until the upper or lower hole of the post is met the mark on the string.
3. Each post must be straight in height and kept same space along the string.

Erecting Long Post

1. Long post should stand in accurate height and space.
2. Upper hole of each post should accurately face vehicle road.
3. When meet irregular road surface such as drain or rocks, posts might be erected irregularly by using support.

Assembling Support and Locker on the bottom of each post

1. Total 16 sets of Support and Locker must be made for 1*8 meter rail.
2. Assemble Support with bolt on left and right of long post, Make sure the bolt not to fasten.
3. Assemble Locker with bolt on front and back of each support. Make sure the bolt not to fasten.
4. Make sure the support and locker for short post inserted as well.

Assembling bottom front and back rail

1. Insert 16 lockers in the bottom back rail and slide the rail up to the end locker.
2. Assemble bottom front rail as the back rail assembled.
3. Fasten bolt for support and locker.
4. Make sure front and back rail must be flat.

Erecting short post

1. Erecting short post by fixing it onto support between long posts every 50cm.
2. Make sure rails are even and fasten all bolts.

Putting Ring and Rotating Barrel

1. Insert a ring onto each long and short post.
2. Insert a rotating barrel onto long and short post.
3. Make sure the rotating barrel not to be upside down.

Assembling upper locker

1. Attaching upper locker on front and back of each post.
2. Locker size will be adjustable depending on road Curves.

Assembling upper rail

1. Assemble the back rail with the locker inserted in the rail.
2. Assemble the front rail as back rail.
- 3 Fasten all bolts.

Connect

1. Insert Sleeve and check washer into the end of rail.
2. Fasten bolts on top of rail.

Cover cap and Finishing

1. Cover the rail with the post cap,
2. Make sure all bolts are fasten tightly (Torque 100~120 N.m = 10.2~12.2 kgf.m)

Testing Methods

The Roller Barrier system is internationally tested for crash and impact test and the following Standards are measured for the performance.

- (i) EN 1317-2 (TB-51) which is for a bus of 13000 Kgs with impact speed of 70 kmph at an Impact angle of 20 degrees.
- (ii) American Association of Highway and Transportation Officials (AASHTO) and as per standards TL-3 & TL-4 (TB12) of Manual for Assessing Safety Hardware (MASH) TB 12 - It is for a for single unit truck with a test inertial mass of 10000 Kgs with an impact speed of 90 kmph at an impact angle of 15 degrees.
- (iii) Accreditation by Indian Roads Congress (IRC) for use on Indian highways Payment shall be made on Rmt basis.

SPECIAL CONDITIONS FOR TECHNICAL CRITERIA

1. The roller Safety Barrier system should be duly accredited by the Indian Road Congress (IRC).
2. The Roller Barrier system should be crash tested and certified by FHWA Approved with AASTHO MASH TL-4 system or The Roller Barrier System Should be crash tested as per EN-1317-5 (Conformity to European standard) And certified by CE with impact intensity B-grade and above only in H1 and H2 certificate or the Roller Barrier system should be crash tested as per SB4/SB5 level (Korean Standard).
3. The Rollers Barrier system should be a single roller crash barrier made of material which is highly Shock absorbing EVA material and durable in nature.
4. Plastic, Poly propylene and HDPE layer cannot be acceptable on Roller as a cover/layer.
5. The rotating plate of the system where the rollers stand must be made of steel material only with Hot dip galvanized.
6. The Roller barrier system must be adopted with sliding technology with additionally shock Absorbing and impact energy converted to rotational energy technology.
7. The Roller should not be made of the materials which are not eco-friendly with the environment. Only Eco-friendly material must be allowed.
8. The bidder should have the required crash test certification in its name or may procure it from Manufacture or authorized representative of the Manufacturers and submit MAF (Manufacturer Authorization Form) duly With the bid documents.
9. CVC's guidelines regarding consideration of Indian agents issued vide letter No. 12-02-6-CTE/SPI(I)- 2/16173 dated 13.01.2012 shall be followed:
10. In the tender, either the India agent on behalf of the Principal/OEM (Original Equipment Manufacturer) or Principal/OEM itself can bid but both cannot bid simultaneously for the same item/product in the same tender.
11. If an agent submits bid on behalf of the Principal/OEM, the same agent shall not submit a bid On behalf of another Principal/OEM in the same tender for the same item/Product.
12. In eligibility criteria the past experience of similar nature of work (Only Roller Safety Barrier Work) by Principal/ OEM or the agent shall be considered.
13. Defect liability shall be 3 (three) years as per SBD. Repairing during DLP shall be done by the agency and its cost will be beared by the agency.
14. All steel elements including posts, beam sections, bolts, nuts, hardware and other steel fittings shall be hot dip galvanized or painted with an approved paint. If galvanized, all elements shall be free from abrasion, rough or sharp edges and shall not be kinked, twisted or bent. Damaged galvanized surfaces, edges of holes and ends of steel sections cut after galvanizing shall be cleaned and re galvanized as per IRC 119:2015 specifications.

15. Location where installation of Roller Crash Barrier is not feasible due to lack of availability of required space for installation or locations where any other work is going on, such stretches may suitably be deleted from the list and got substituted with concurrence of the concerned authority.

Deputy Executive Engineer
Road (R&B) Sub Division
Bhuj – Kutch

Executive Engineer
R&B Division
Bhuj – Kutch