

spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material determined as per IS: 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

402.5. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 902.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

402.6. Arrangement for Traffic

During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 112.

402.7. Measurement for Payment

Granular sub-base shall be measured as finished work in position in cubic metres.

The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

402.8. Rate

The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including full compensation for:

- (i) making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;
- (ii) furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;
- (iii) all labour, tools, equipment and incidentals to complete the work to the Specifications;
- (iv) carrying out the work in part widths of road where directed; and
- (v) carrying out the required tests for quality control.

Item No. :- 37

Providing and laying and rolling of 20mm thick compacted mix seal surface with B.T. and aggregate as specified using bitumen for mixing with aggregate at the rate of 5.10% i.e. 51.00kg/ M.T. of total mix, including heating and mixing in drum mix plant and spreading the same by paver finisher and con solidation with vibratory roller including necessary firewood, oil, lubricants, labour charges, using contractor's own drum mix plant, machineries and equipment, tools etc including fushing of sand 0.30 cum/10sqm. etc complete in accordance with the requirement of specification.

1. The work shall consist of constructing in a single course of mix seal surfacing as course on a previously prepared base of carpet single course shall also include additional thickness. If any. to remove unevenness of the existing surface.

3. The fine aggregates shall consist of crushed run screening, natural sand or mixture of both. There shall be clean hard durable, uncoated, dry and free from injurious, soft or flaky pieces and organic or deleterious substance.

4. The filler, where required, shall be an inert material, the whole of which passes 600 micron sieve at least 90 percent passing 150 micron sieve and not less than 70 percent passing 75 micron sieve. The filler shall be cement, stone dust, hydrated lime or fly ash approved by the Engineer in charge.

5. The aggregates shall be so graded or combined as to confirm to the grading as under.

Sieve Designation	Percent by weight passing Sieve for type 'A' Mix seal surfacing.
20mm	100
7.75mm	40-85
7.36mm	5-10
75 micron	0-4

6. The samples of aggregate of requires gradings for the work shall be got approved from the Enginecrin-charge prior to transportation and collection on plant site. Unapproved materials shall have to be removed from the plant site by the contractor at his own cost. If contractor fails to remove the inferior type of materials from the plant site, the same will be removed by the Department at the cost of the Contractor Collection of aggregate shall be in different stacks according to various sizes of aggregates.

7. For the purpose of collection of materials, plant site shall be established at suitable place, where hot mix plant shall be installed. Department will extend all necessary co-operation in helping Contractor to get nearby Government land of establishing plant site. However, department is not responsible if no such land is made available to the Contractor and in that case, the Contractor will have to make his own arrangement for the same. Incoming material shall be recorded in a register for the purpose of record.

8. The binder shall be straight run bitumen of a suitable grade satisfying the requirements of IS:73. Bitumen shall be 60/80/100 grade and shall be supplied by the department at the rate and place as mentioned in Schedule "A" of the tender and it shall have to be carted, by the Contractor to the site of work at his own cost. Empty asphalt drums shall have to be returned free of cost to P.W.D. Store from where they are issued or as directed, if so provided in Schedule 'A' Any damage caused to the asphalt drums or loss of asphalt after issue from store shall be the responsibility of the Contractor. Drums of asphalt shall be so stored JQ as to allow easy inspection and \r such place as will not damage the drums and cause the leakage of allow water and other foreign matter to enter For the purpose of calculating consumption, wastage will not be 'allowed beyond 2.5 percent Excess consumption over 2.5 percent will be charged at a panel rate.

9. In case bitumen is to be issued by department in bulk, the same shall be issued to the Contractor at plant site by tankers at the same rate as shown in Schedule 'A'. Contractor shall have to make adequate arrangement for slacking bulk asphalt at plant site according to the requirement. No deduction in rate will be made for supplying heated bulk asphalt.

10. The asphalt should not be used as a fuel. If however, Contractor is found to be using asphalt as fuel, The quantity of asphalt utilised shall be assessed, by the Executive Engineer whose decision will be final and binding to the Contractor who will be charged at double the rate provided in Schedule 'A' of the agreement even though the total consumption of asphalt may be within the theoretical consumption.

11. Department shall keep a day to day account of the supply and consumption of bitumen in a separate bound register having numbered pages and the proforma prescribed by the Department. Day to day signature of the Contractor's representative shall be obtained in this register. Issue rate of bitumen includes (i) Obtaining asphalt from Department's store, (ii) Transporting to site, (iii) Storing and stacking, (iv) Keeping records of supply and consumption and (v) returning the empty drums in good condition to the Department.

12. Mix seal surfacing shall not be laid during rainy weather or when the base course is damp or wet.

13. The base on which mix seal surfacing is to be laid shall be thoroughly cleaned and free of dust and foreign matter.

14. The work shall consist of application of mix seal surfacing of single coat of bituminous material to an existing carpet surface preparatory to bituminous construction. The temperature of bitumen at the time of application shall be in the range of 160 degree centigrade to 175 degree centigrade.

16. Tack coat for mix seal surfacing shall be applied as the work of laying mix seal surfacing is being preceded by a bituminous open graded carpet.

17. The binder content for pre mixing shall be 4% by weight of the total unless otherwise specified in item of schedule B of the work. Quantity of aggregate shall be sufficient to yield the specified thickness after compaction.

18. Hot mix plant of adequate capacity and capable of producing a proper and uniform quality shall be used for preparing the mix. The plant may be either a batch type or a continuous one, having coordinated set of essential unit such as dryer for heating the aggregates, a binder heating and control unit for metering out the correct quantity of heated binder together with a paddle mixer for intimate mixing of the binder and aggregate.

19. The temperature of binder at the time of mixing shall be in the range of 150 - 177 degree centigrade and of aggregates in the range of 155 - 163 degree centigrade. Provided also that, at no time shall the difference in temperature between the aggregates and the binder exceed 14 degree centigrade.

20. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all the particles to the mineral aggregates are coated uniformly.

21. The mix shall be transported from the mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over during transit if so directed by the Engineer-in-charge.

22. The mix transported from the hot mix plant to the site, shall be spread by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix, to specified grade, lines and cross sections. The temperature of mix at the time of laying shall be in range 121-163 degree centigrade.

23. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal joints shall be offset by at least 150 mm. from those in the binder course. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

24. Immediately after the spreading of mix, it shall be thoroughly compacted by 8-10 tonnes 3 Wheel . roller moving at a speed not exceeding 5 km per hour.

25. The roller wheels shall be kept damp to prevent the mix from adhering to them but in no case shall fuel lubricating oil be used for this purpose. Rolling shall commence longitudinally from the edge and progress towards the centre except on super elevated portions. When it shall progress from the lower to upper edge parallel to the centre line of the pavement. The roller should/proceed on the fresh material with rear or mixed wheel leading or as to minimise the pushing of the mix and each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. Rolling shall continue until the entire surface has been rolled to compaction and all the roller marks eliminated.

26. Sand or stone dust flushing at the rate of 0.03 cmt / 10 smt. shall be done on asphalt surface for which no separate payment will be made.

27. Traffic may be allowed immediately after completion of the final rolling when the mix has cooled down to the surrounding temperature.

28. Surface finish and quality control of work : Control on the quality of materials and works shall be exercised by the Engineer-in-charge by carrying out the following test at the frequencies shown against each :-

Sr. No.	Type of Construction	Test	Frequency.
1	1. Tack Coat	(i) Binder temperature for application	At regular close intervals.
		(ii) Rate of spread of binder	Two test per day
2	2. Semi-Dense Carpet	(i) Aggregate Impact Value	One test per 100 Cu. m. of aggre
		(ii) Flakiness Index of Aggre.	-DO-
		(iii) Stripping Value	-DO-
		(iv) Mix Grading	One set of test on individual constituents and mixed aggregates from the dryer for each 100 tonnes of mix subject to a minimum of two test per day
		(v) Temperature of binder in the boiler, aggregate in the dryer and mix at the time of laying and rolling	At regular close intervals
		(vi) Control of binder content and gradation in the mix (Binder Content test vide (ASTM D-2172)	One test for each 100 tonnes of mix subject to max. of two test per day per plant

	(vii) rate of spread mix material	Regular control through checks on layer thickness
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29. The contractor shall at all times carry out work on the highway in a manner creating least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all work involving improvements to the existing highway, the contractor shall in accordance with the directives if the Engineer-in-charge provide and maintain, during the execution of the work, a passage for traffic either along a part of the existing carriage way under improvement or on diversion.

30. In case of the improvement works, namely widening strengthening of the existing payment or reconstruction repairs-to cross-drainage works. Where such works could be carried out on part widths at a time and the traffic could simultaneously be passed without undue delay and difficulty on the other part; the road shoulder shall be dressed and brought in-line with the oayment and maintained throughout out the duration of the work to the satisfaction of the Engineer-in-charge Where work is continued on long stretches, passing places, at least 20 metre long and 6 metre wide inclusive of the width of the existing carriage way shall be provided at half or one kilometer intervals as directed by the Engineer-m-charge. Extra treatment to shoulders where necessary, shall be given as ordered by the Engineer-in-charge

31. The contractor shall take the all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades including signs, marking lights and flagmen as may be required, by the Engineer-in-charge for the information and protection of traffic approaching or passing through the section, of the highway under improvement. Before taking up any construction an agreed phased programme for the control of traffic on the highway shall be drawn up m consultation with the Engineer-in-charge.

32. The barricades erected on either side of the carriage be passed without undue delay and difficulty on the other part; the road shoulder shall be dressed and brought in-line with the oayment and maintained throughout out the duration of the work to the satisfaction of the Engineer-in-charge Where work is continued on long stretches, passing places, at least 20 metre long and 6 metre wide inclusive of the width of the existing carriage way shall be provided at half or one kilometer intervals as directed by the Engineer-m-charge. Extra treatment to shoulders where necessary, shall be given as ordered by the Engineer-in-charge 31. The contractor shall take the all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades including signs, marking lights and flagmen as may be required, by the Engineer-in-charge for the information and protection of traffic approaching or passing through the section, of the highway under improvement. Before taking up any construction an agreed phased programme for the control of traffic on the highway shall be drawn up m way/portion of the carriage way closed to traffic shall be strong to resist violation, and painted with alternate black and white stripes. Red lanterns or warning lights of similar type shall be mounted on the barricades at night and kept lit throughout from sunset to sunrise. At the points where traffic is to deviate from its normal path the channel for traffic shall be clearly marked with the aid of payment marking painted drums or a similar device to the direction of the Engineer-in-charge. At night the passages shall be delineated with lanterns or other suitable light source.

33. One way traffic operation shall be established whenever the traffic is to be passed over part of the carriage way inadequate for two lane traffic. This shall be done with the help of flagmen kept positioned on opposite side during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns lights. On both sides, suitable regulatory/warning sings shall be installed for the guidance of carriage way begins and the other 120 metres away. The signs shall be of approved design and the refractory type if so directed.

34. The payment shall be made on the tonnage basis of the weight of mix of aggregate and bitumen. For this purpose the contractor shall have to install a weigh bridge of suitable capacity for the purpose of weighing of dumpers at suitable place at his cost as directed. Weight of empty dumper and weight of loaded dumper will be recorded in bound and numbered register on plant site. Department will be free to get some loaded dumpers test checked at other weigh bridges. Weigh bridge will be periodically got calibrated and verified from weight and measure authorities.

35. Weight of mix materials will be done in presence of responsible person, not less than the rank of supervisor of Department and the measurements shall be recorded by the Deputy Engineer. Junior Engineer or Supervisor, if so authorised. Record of each dumper will be maintained separately in bound and numbered register which will be maintained by the department representatives and signed by the contractor. Proper gate pass system shall be established, for the vehicles coming to the plants, site and out going from the plant site. The location of hectometre in which individual dumpers are unloaded shall be recorded carefully.

36. The contract unit rate for mix seal surfacing shall be paid in full for carrying out the required operation including full compaction for:

1. Making arrangement of control and safety of traffic.
2. Preparation of base.
3. Providing all materials to be incorporated in the works with all lead and lift.
4. All labours, tools, equipments and incidental to complete the works to the specification.

Item No. :- 38

Supplying and fixing reinforced concrete heavy duty non-pressure pipes with collars for culverts carrying heavy traffic as per IS 458 1971 specifications including setting the pipes in C.M. 1 :2 watering and laying (to level or slopes) of class NP 3 of following internal diameters. (III) 600 mm dia

1. The work shall consist of furnishing and installing reinforced cement concrete pipe of the type dia metre and length required at the location shown on the drawings or as ordered by the Engineer-in-charge.

2. Reinforced concrete pipe shall be NP3 type conforming to the requirements of IS : 458 and shall be of dia as specified in the item. Each consignment of cement concrete pipes shall be inspected, if necessary and approved by the Engineer-in-charge, either at the palce of manufacture or at the site before their incorporation in the works.

NP3, NP2, NP1 pipes are used for R. C. C. Pipes, where testing of pipes will not be feasible the contractors will have to produce a certificate from the manufacturers on company's latter head the given hereinafter form.

Production of such certificate will not however relieve the contractor from his responsibility of supplying pipes of required standard and will have to bear the loss or damage caused to the work on account of defects found subsequently during the execution. It will also be necessary to purchase these pipes from manufacturer having standard equipments for carrying out various test as per IS : 458 at his factory.

FORM OF CERTIFICATE FOR NP3, NP2, NP1 PIPES

We _____ manufacturer of R.C.C. pipes produce B.C.C. pipes as per the requirement of IS: 458 and also carry out the required test at our place. We have acquired equipments for carrying out test and are prepared to carryout test at our factory sites. We have experience of manufacturing of pipes of _____ years The pipes supplied by us to

M/s. _____ satisfy the requirement of IS : 458

Date: _____

Place :. _____

Manufacturer's Sign _____

3. No pipe shall be palced in position until the foundations have been approved by the Engineer-incharge. Where two pr more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at feat half the diametre of the pipe subject to minimum of 450 mm. The laying of pipes on the prepared foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid in works they form a culvert with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed at there cost of Contractor.

4. The pipes shall be jointed either by collar joint or by flush joint. In the former case, the collars shall be of R.C.C., 150 to 200 mm wide and having the same strength as the pipes to be jointed. Caulking, space shall be between 13 and 20 mm according to the diametre of the pipes., Caulking material shall be slightly wet mix of cement and sand in the ratio of 1:2 rammed with Caulking irons. Before caulking the collar shall be so placed that its centre coincides with that of pipe and an even annular space is left between the collar and the pipes. Flush joint may be shaped to form a self centering joint with a joining space 13 cm wide. The joining space shall be filled with cement mortar. 1 cement to 2 sand, mixed sufficiently dry to remain in position

when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damp for at least four days.

5. R. C. C. pipe shall be measured along their centre between their inlet and outlet ends in linear metres.

6. The rate for the pipes shall include the cost of pipe including loading, unloading, handling storing laying in position and joining complete.

Item No. :- 39

Diversion Ahead Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 180x60 cms. rectangular as per design of IRC-67-2012. Pre treated with phospheting process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint ; reflectorised with Micro Prismatic Grade retro reflectivesheeting of Type-11 as per ASTM D-4956 and latest M.O.S.T.Specifications; 3.1 mtr long stand post (2 Nos.) of 50 x 50 x 5mm / 50NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with bestquality epoxy coatings in black and white bends. The details of symbol foreach board shall be as per theinstruction of engineer in charge. The fixing at site shall be in 1:2:4 CC blockof 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 10 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-C Type-11 Retro Reflective sheeting

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 M-15 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 Aluminium sheet, aluminium composite panel, fibre glass sheeting, or sheet moulding compound. Aluminium sheets used for sign boards shall be of smooth, hard and corrosion resistance aluminium alloy conforming to IS: 736-Material Designation 24345 or 1900. Aluminium composite Materials (ACM) sheets shall be sandwiched construction with a thermoplastic core of Low Density Polyethylene (LDPE) between two thick skings/sheets of aluminium with overall thickness of 3mm or 4mm (as specified in the contract), and aluminium skin thickness 0.5mm and 0.3 mm respectively on both the sides.

The mechanical proportion of ACM and that of aluminium 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 Aluminium Composite Material (ACM)

Sr. No.	Description	Specification for 4mm		Specification for 3 mm
		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.40N/mm ²	Min.30N/mm ²
3	0.2 % Proof Stress	ASTM E8	Min.34N/mm ²	Min.34N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5%
5	Flexural strength	ASTM C393	Min.130N/mm ²	Min.120N/mm ²
6	Shear strength with Punch shear	ASTM D732	Min.18 N/mm ²	Min. 18 N/mm ²
B	PROPERTIES OF ALUMINIUM SKING			
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%	A50 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 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminium 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 or 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 rising 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
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0.1 ^{oB}	-4°	300	200	120	54	54	24	14
0.1 ^{oB}	+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

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

^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 coefficient 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 ^{oB}	-4°	500	380	200	70	90	42	25	400	300	150
0.1 ^{oB}	+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

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

^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.

1.3.4. PRISMATIC GRADE SHEETING :

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-reflective for Type VIII 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 ^{oB}	-4°	1000	750	375	100	150	45	30	800	600	300
0.1 ^{oB}	+30°	460	345	175	46	69	21	14	370	280	135

0.2°	-4°	700	525	265	70	10 5	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

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

^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 1 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 dr 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-reflective for Type VIII 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	13 0	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
0.1°	-4°	80	60	30	8	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2	36	27	14

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

^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 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3. 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 dr 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-reflective for Type VIII 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	12 5	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
0.1°	-4°	120	90	42	12	18	5	4	96	72	36
0.1°	+30°	45	34	16	5	7	2	1	36	27	14

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

^B Values 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 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 5mm. 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 percent of the corresponding value 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.
- 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

Table 8.1 Specification Limits (Daytime)^A								
Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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 informant or guide signs shall be distinct for different categories of roads. For National Highway and State Highways, these signs shall be of green background with white boarder, legends and word messages. For Expressways these signs shall be of blue background with white boarder, legenes and word messages.

1.3.9 REFURBISHMENTS:

Where exisiting signs are specifired for refurbishments, the sheeting shall have semi-rigid aluminium 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 sign 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 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 informant 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 Highway and 100 mm for other roads. In case of overhead signs, the size ('x' height) of letters may be minimum 300mm. 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 (7) 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 bounding 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 colour 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 which may be GI pipes conforming to IS 1239. Rectangular Hollow Section conforming to IS 4923 or square hollow section conforming to IS 589. 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 Specification 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 Unit shall be on number basis as applicable

1.6 RATE :

The contract unit rate shall be payment in full for the cost of making the road sign board, including all materials, labour charges, 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 or 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 retro reflective sheeting conforming 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 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 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.

Item No. :- 40

Providing and fixing ordinary Kilometer stone of precast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design in C.C. 1:4:8 including letter and paints etc. complete (For N.H., S.H. and M.D.R.)

1. Kilometer stone shall be of approved quality and shall be either black Rajula stone or of precast 1:2:4 R.C.C. as specified in the item.
2. The size manner of fixing painting and lettering of K.M. stone shall conform specification as per I.R.C.-8 (Type design for Highway kilometre stones). The fixing of K.M. stone shall be carried out in ordinary concrete of grade specified in the item using hand broken metal field metal or gravel. The measurement for payment shall be made per No. of K.M. stone fixed in position.
3. Unit rate for kilometre stone includes the cost of all materials, labour, tools, fixing, finishing curing, lettering and painting as directed by the Engineer-in-charge.

Item No. :- 41

Providing and fixing 5th Kilometer stone of precast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design in C.C. 1:4:8 including letter and paints etc. complete (For N.H., S.H. and M.D.R.)

1. The work shall be carried out as per the item of ordinary kilometre stone except that the size of the fifth kilometre stone shall be bigger than that of ordinary kilometre stone as per I.R.C.-8 (Type design for highway kilometre stones). The fixing of K. M. stone shall be in ordinary concrete of grade specified in the item. The measurement for payment as well as the operation included in the unit rate shall be as per ordinary kilometre stone.

Item No. :- 42

Providing and fixing Hectometer of precast C.C. 1:2:4 including necessary reinforcement as per I.R.C. type design including painting lettering and etc. complete. (II) Fixing in C.C. 1:5:10

(1) Fixing in Earth : The work shall be carried out as per the item of ordinary kilometre stone except that the size of Hectometre stone shall be smaller than that of ordinary kilometre stone as per I.R.C. 26 (Type design for 200 metre stones) and fixing shall be in earth. The measurement for payment as well as the operations included in the unit rate shall be as per ordinary kilometres stone.

(2) Fixing in C. C. 1:5:10

Specification same as 11 (1) above except that the indicator stone shall be fixed in C.C. 1:5:10 which will consist of one part of cement, five part of good sand and ten parts of good brick bats. Rate includes all labour and curing etc. necessary for concrete.

Item No. :- 43

Providing and fixing guard stone as per IRC type design including white washing etc complete (i) Fixing in C.C. 1:5:10

(1) Fixing in earth.

1 . Indicator stones shall be of approved quality and of the size 20 cm x 20 cm its length shall not be less than 80 cms. The top. 38 cm shall be chisel dressed on all sides. The size shape and dimension of the indicator stone shall be exact and stones shall be neatly dressed and finished before fixing. The indicator stones shall be fixed firmly in position in embankment or cutting as the case may be. The exposed part of the indicator stone shall be done by the contractor at his own cost. The measurement for payment shall be per number of indicator stone fixed in position.

2. Unit rate indicator stone includes the cost of all materials labour, tools, fixing, and white washing as directed by the Engineer-in-charge.

(2) Fixing in C. C. 1:5:10

Specification same as 11 (1) above except that the indicator stone shall be fixed in C.C. 1:5:10 which will consist of one part of cement, five part of good sand and ten parts of good brick bats. Rate includes all labour and curing etc. necessary for concrete.

Item No. :- 44

Providing and fixing indicator stone of approved stone as per I.R.C. type design in C.C. 1:4:8 including white washing etc. complete.(ii) Fixing in C.C. 1:5:10

(1) Fixing in earth.

1 . Indicator stones shall be of approved quality and of the size 20 cm x 20 cm its length shall not be less than 80 cms. The top. 38 cm shall be chisel dressed on all sides. The size shape and dimension of the indicator stone shall be exact and stones shall be neatly dressed and finished before fixing. The indicator stones shall be fixed firmly in position in embankment or cutting as the case may be. The exposed part of the indicator stone shall be done by the contractor at his own cost. The measurement for payment shall be per number of indicator stone fixed in position.

2. Unit rate indicator stone includes the cost of all materials labour, tools, fixing, and white washing as directed by the Engineer-in-charge.

(2) Fixing in C. C. 1:5:10

Specification same as 11 (1) above except that the indicator stone shall be fixed in C.C. 1:5:10 which will consist of one part of cement, five part of good sand and ten parts of good brick bats. Rate includes all labour and curing etc. necessary for concrete.

Item No. :- 45

Supplying and fixing road sign board of M.S. plate and angle IR including painting, lettering etc complete including fixing in CC 1:4:8 with necessary excavation etc. complete as per IRC Type design (II) Reflective Type.

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.

1.4 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 M-15 grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.7 REINFORCING STEEL

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

1.2.8 BOLTS, NUTS AND WASHERS

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

1.2.9 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.

1.2.10 SUBSTRATE

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

The mechanical proportion of ACM and that of aluminium 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 Aluminium Composite Material (ACM)

Sr. No.	Description	Specification for 4mm		Specification for 3 mm
		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.40N/mm ²	Min.30N/mm ²
3	0.2 % Proof Stress	ASTM E8	Min.34N/mm ²	Min.34N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5%
5	Flexural strength	ASTM C393	Min.130N/mm ²	Min.120N/mm ²
6	Shear strength with Punch shear	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%	A50 Min. 2%
4	0.2 % Proof Stress	ASTM E8	Min.110 N/mm ²	Min.110 N/mm ²

1.2.11 PLATE THICKNESS

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminium 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.

1.5 TRAFFIC SIGNS HAVING RETRO RELECTIVE SHEETING

1.5.1 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 or 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.

1.5.2 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 rising 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

Minimum Coefficient of Retro reflective (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 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

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

^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.

1.3.4. PRISMATIC GRADE SHEETING :

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-reflective for Type VIII 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°	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

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

^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 1 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-reflective for Type VIII 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
0.1°	-4°	80	60	30	8	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2	36	27	14

Minimum Coefficient of Retro reflective (R_A) ($\text{cd} \cdot \text{lx}^{-1} \cdot \text{m}^{-2}$)

^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 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3. 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 800-6

Table 800-6 Acceptable Minimum Coefficient of Retro-reflective for Type VIII 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
0.1°	-4°	120	90	42	12	18	5	4	96	72	36
0.1°	+30°	45	34	16	5	7	2	1	36	27	14

Minimum Coefficient of Retro reflective (R_A) ($\text{cd} \cdot \text{lx}^{-1} \cdot \text{m}^{-2}$)

^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 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 5mm. 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 percent of the corresponding value 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.

1.3.9 COLOR FOR SIGNS :

1.3.8.6. 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.

1.3.8.7. 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.

1.3.8.8. 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

Table 8.1 Specification Limits (Daytime) ^A								
Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771

Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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

- 1.3.8.9. The mandatory and warning signs shall be provided with white background and red border. The legend / symbol for these signs shall be in black
- 1.3.8.10. The colours chosen for informant or guide signs shall be distinct for different categories of roads. For National Highway and State Highways, these signs shall be of green background with white boarder, legends and word messages. For Expressways these signs shall be of blue background with white boarder, legenes and word messages.

1.3.9 REFURBISHMENTS:

Where existings signs are specifiored for refubishments, the sheeting shall have semi-rigid aluminium 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 sign 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 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 informant signs and definition plates.

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

1.4.10.3 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.

1.4.11 WARRANTY AND DURABILITY :

The Contractor shall obtain from the original manufacturer of the Retro-Reflective sheeting for period of ten (7) 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 bounding 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 colour 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.

1.5 INSTALLATION :

1.4.1. The traffic signs shall be mounted on support posts, which may be of GI pipes which may be GI pipes conforming to IS 1239. Rectangular Hollow Section conforming to IS 4923 or square hollow section conforming to IS 589. 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 Specification 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 Unit shall be on number basis as applicable

1.6 RATE :

The contract unit rate shall be payment in full for the cost of making the road sign board, including all materials, labour charges, 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 or its subsidiary. In India. Certificate issued by distributor dealer / power fo 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 Pe-qualification warranty for Calls-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 retro reflective 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 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 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.

Item No. :- 46

Direction (Junction) Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 244x122 cms. rectangular as per design of IRC-67-2012. 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 reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 4.0mtr (2 Nos.) long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 50x50x5mm; painted with best quality epoxy coatings in black and white bends. The details of symbol 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. (B) Class-B Type-4 Retro Reflective sheeting.

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.

1.6 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 M-15 grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.12 REINFORCING STEEL

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

1.2.13 BOLTS, NUTS AND WASHERS

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

1.2.14 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.

1.2.15 SUBSTRATE

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

The mechanical proportion of ACM and that of aluminium 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 Aluminium Composite Material (ACM)

Sr. No.	Description	Specification for 4mm		Specification for 3 mm
		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.40N/mm ²	Min.30N/mm ²
3	0.2 % Proof Stress	ASTM E8	Min.34N/mm ²	Min.34N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5%
5	Flexural strength	ASTM C393	Min.130N/mm ²	Min.120N/mm ²
6	Shear strength with Punch shear	ASTM D732	Min.18 N/mm ²	Min. 18 N/mm ²
B	PROPERTIES OF ALUMINIUM SKING			
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

1.2.16 PLATE THICKNESS

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminium 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.

1.7 TRAFFIC SIGNS HAVING RETRO REFLECTIVE SHEETING

1.7.1 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 or 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.

1.7.2 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 ^{oB}	-4°	300	200	120	54	54	24	14
0.1 ^{oB}	+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

Minimum Coefficient of Retro reflective (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 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 ^{oB}	-4°	500	380	200	70	90	42	25	400	300	150
0.1 ^{oB}	+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

Minimum Coefficient of Retro reflective (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 reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4. PRISMATIC GRADE SHEETING :

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-reflective for Type VIII Prismatic Grade sheeting^A

(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent	Fluorescent Yellow	Fluorescent Orange
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	Angle								Yellow -Green		
0.1° ^B	-4°	100 0	750	375	100	15 0	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	10 5	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

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

^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 1 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-reflective for Type VIII 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	13 0	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
0.1°	-4°	80	60	30	8	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2	36	27	14

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

^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 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3. 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 800-6

Table 800-6 Acceptable Minimum Coefficient of Retro-reflective for Type VIII 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
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0.1° ^B	-4°	830	620	290	83	12 5	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
0.1°	-4°	120	90	42	12	18	5	4	96	72	36
0.1°	+30°	45	34	16	5	7	2	1	36	27	14

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

^B Values 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 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 5mm. 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 percent of the corresponding value 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.

1.3.10 COLOR FOR SIGNS :

- 1.3.8.11. 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.
- 1.3.8.12. 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.
- 1.3.8.13. 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

Table 8.1 Specification Limits (Daytime)^A

Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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

- 1.3.8.14. The mandatory and warning signs shall be provided with white background and red border. The legend / symbol for these signs shall be in black
- 1.3.8.15. The colours chosen for informant or guide signs shall be distinct for different categories of roads. For National Highway and State Highways, these signs shall be of green background with white boarder, legends and word messages. For Expressways these signs shall be of blue background with white boarder, legenes and word messages.

1.3.9 REFURBISHMENTS:

Where existng signs are specifired for refubishments, the sheeting shall have semi-rigid aluminium 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 sign 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 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 informant signs and definition plates.

1.5.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for National and State Highway and 100 mm for other roads. In case of overhead signs, the size ('x' height) of letters may be minimum 300mm. Thickness of the letter could be varied from 1/6 to 1/5 of the letter 'x' size. The size of the 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.

1.5.10.3 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.

1.5.11 WARRANTY AND DURABILITY :

The Contractor shall obtain from the original manufacturer of the Retro-Reflective sheeting for period of ten (7) 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 bounding 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 colour 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.

1.6 INSTALLATION :

1.4.1. The traffic signs shall be mounted on support posts, which may be of GI pipes which may be GI pipes conforming to IS 1239. Rectangular Hollow Section conforming to IS 4923 or square hollow section conforming to IS 589. 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 Specification 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 Unit shall be on number basis as applicable

1.6 RATE :

The contract unit rate shall be payment in full for the cost of making the road sign board, including all materials, labour charges, 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 or its subsidiary. In India. Certificate issued by distributor dealer / power fo 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 Pe-qualification warranty for Calls-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 retro reflective 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 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 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.

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Village name Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 90x60 cms. rectangular as per design of IRC-67-2012. Pre treated with phosphating 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 reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.3mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; 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. (B) Class-B Type-4 Retro Reflective sheeting.

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.

1.8 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 M-15 grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.17 REINFORCING STEEL

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

1.2.18 BOLTS, NUTS AND WASHERS

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

1.2.19 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.

1.2.20 SUBSTRATE

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

The mechanical proportion of ACM and that of aluminium 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 Aluminium Composite Material (ACM)

Sr. No.	Description	Specification for 4mm		Specification for 3 mm
		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.40N/mm ²	Min.30N/mm ²
3	0.2 % Proof Stress	ASTM E8	Min.34N/mm ²	Min.34N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5%
5	Flexural strength	ASTM C393	Min.130N/mm ²	Min.120N/mm ²
6	Shear strength with Punch shear	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

1.2.21 PLATE THICKNESS

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminium 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.

1.9 TRAFFIC SIGNS HAVING RETRO REFLECTIVE SHEETING**1.9.1 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 or 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.

1.9.2 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 ^{oB}	-4°	300	200	120	54	54	24	14
0.1 ^{oB}	+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

Minimum Coefficient of Retro reflective (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 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 coefficient 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 ^{oB}	-4°	500	380	200	70	90	42	25	400	300	150
0.1 ^{oB}	+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

Minimum Coefficient of Retro reflective (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 reflectance indicated in above Table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4. PRISMATIC GRADE SHEETING :

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-reflective for Type VIII Prismatic Grade sheeting^A

(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent	Fluorescent Yellow	Fluorescent Orange
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	Angle								Yellow -Green		
0.1 ^{0B}	-4°	1000	750	375	100	150	45	30	800	600	300
0.1 ^{0B}	+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

Minimum Coefficient of Retro reflective (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 reflectance indicated in above Table. At the end of 1 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 dr 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-reflective for Type VIII 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 ^{0B}	-4°	660	500	250	66	130	30	530	400	200
0.1 ^{0B}	+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
0.1°	-4°	80	60	30	8	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2	36	27	14

Minimum Coefficient of Retro reflective (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 reflectance 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 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 dr 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-reflective for Type VIII 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
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0.1° ^B	-4°	830	620	290	83	12 5	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
0.1°	-4°	120	90	42	12	18	5	4	96	72	36
0.1°	+30°	45	34	16	5	7	2	1	36	27	14

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

^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 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 5mm. 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 percent of the corresponding value 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.

1.3.11 COLOR FOR SIGNS :

- 1.3.8.16. 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.
- 1.3.8.17. 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.
- 1.3.8.18. 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

Table 8.1 Specification Limits (Daytime) ^A								
Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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

- 1.3.8.19. The mandatory and warning signs shall be provided with white background and red border. The legend / symbol for these signs shall be in black
- 1.3.8.20. The colours chosen for informant or guide signs shall be distinct for different categories of roads. For National Highway and State Highways, these signs shall be of green background with white boarder, legends and word messages. For Expressways these signs shall be of blue background with white boarder, legenes and word messages.

1.3.9 REFURBISHMENTS:

Where exisiting signs are specifired for refubishments, the sheeting shall have semi-rigid aluminium 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 sign 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 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 informant signs and definition plates.

1.6.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for National and State Highway and 100 mm for other roads. In case of overhead signs, the size ('x' height) of letters may be minimum 300mm. 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.

1.6.10.3 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.

1.6.11 WARRANTY AND DURABILITY :

The Contractor shall obtain from the original manufacturer of the Retro-Reflective sheeting for period of ten (7) 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 bounding 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 colour 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.

1.7 INSTALLATION :

1.4.1. The traffic signs shall be mounted on support posts, which may be of GI pipes which may be GI pipes conforming to IS 1239. Rectangular Hollow Section conforming to IS 4923 or square hollow section conforming to IS 589. 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 Specification 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 Unit shall be on number basis as applicable

1.6 RATE :

The contract unit rate shall be payment in full for the cost of making the road sign board, including all materials, labour charges, 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 or 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 retro reflective sheeting conforming 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 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 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.

Item No. :- 48

Chevron sign :- Providing and fixing sign boards made out of 1.5mm aluminium sheet / 3mm ACP (Aluminum composite Panel); size 60x50cm rectangular as per design of IRC-67-2012. 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 reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 3.3 mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35x35x3mm; 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.

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.

1.10 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 M-15 grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.22 REINFORCING STEEL

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

1.2.23 BOLTS, NUTS AND WASHERS

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

1.2.24 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.

1.2.25 SUBSTRATE

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

The mechanical proportion of ACM and that of aluminium 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 Aluminium Composite Material (ACM)

Sr. No.	Description	Specification for 4mm		Specification for 3 mm
		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.40N/mm ²	Min.30N/mm ²
3	0.2 % Proof Stress	ASTM E8	Min.34N/mm ²	Min.34N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5%
5	Flexural strength	ASTM C393	Min.130N/mm ²	Min.120N/mm ²
6	Shear strength with Punch shear	ASTM D732	Min.18 N/mm ²	Min. 18 N/mm ²
B	PROPERTIES OF ALUMINIUM SKING			
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

1.2.26 PLATE THICKNESS

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminium 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.

1.11 TRAFFIC SIGNS HAVING RETRO REFLECTIVE SHEETING

1.11.1 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 or 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.

1.11.2 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 ^{oB}	-4°	300	200	120	54	54	24	14
0.1 ^{oB}	+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

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

^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 coefficient 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 ^{oB}	-4°	500	380	200	70	90	42	25	400	300	150
0.1 ^{oB}	+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

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

^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.

1.3.4. PRISMATIC GRADE SHEETING :

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-reflective for Type VIII Prismatic Grade sheeting^A

(Candelas Per Lux Per Square Metre)

Observation Angle	Entrance	White	Yellow	Orange	Green	Red	Blue	Brown	Fluorescent	Fluorescent Yellow	Fluorescent Orange
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	Angle								Yellow -Green		
0.1° ^B	-4°	100 0	750	375	100	15 0	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	10 5	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

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

^B Values 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 1 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 dr 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-reflective for Type VIII 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	13 0	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
0.1°	-4°	80	60	30	8	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2	36	27	14

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

^B Values 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 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3. 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 dr 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-reflective for Type VIII 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
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0.1 ^{0B}	-4°	830	620	290	83	12 5	37	25	660	500	250
0.1 ^{0B}	+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
0.1°	-4°	120	90	42	12	18	5	4	96	72	36
0.1°	+30°	45	34	16	5	7	2	1	36	27	14

Minimum Coefficient of Retro reflective (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 reflectance 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 5mm. 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 percent of the corresponding value 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.

1.3.12 COLOR FOR SIGNS :

- 1.3.8.21. 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.
- 1.3.8.22. 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.
- 1.3.8.23. 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

Table 8.1 Specification Limits (Daytime)^A								
Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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

- 1.3.8.24. The mandatory and warning signs shall be provided with white background and red border. The legend / symbol for these signs shall be in black
- 1.3.8.25. The colours chosen for informant or guide signs shall be distinct for different categories of roads. For National Highway and State Highways, these signs shall be of green background with white boarder, legends and word messages. For Expressways these signs shall be of blue background with white boarder, legenes and word messages.

1.3.9 REFURBISHMENTS :

Where exisiting signs are specifiired for refubishments, the sheeting shall have semi-rigid aluminium 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 sign 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 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 informant signs and definition plates.

1.7.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for National and State Highway and 100 mm for other roads. In case of overhead signs, the size ('x' height) of letters may be minimum 300mm. 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.

1.7.10.3 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.

1.7.11 WARRANTY AND DURABILITY :

The Contractor shall obtain from the original manufacturer of the Retro-Reflective sheeting for period of ten (7) 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 bounding 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 colour 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.

1.8 INSTALLATION :

1.4.1. The traffic signs shall be mounted on support posts, which may be of GI pipes which may be GI pipes conforming to IS 1239. Rectangular Hollow Section conforming to IS 4923 or square hollow section conforming to IS 589. 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 Specification 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 Unit shall be on number basis as applicable

1.6 RATE :

The contract unit rate shall be payment in full for the cost of making the road sign board, including all materials, labour charges, 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 or its subsidiary. In India. Certificate issued by distributor dealer / power fo 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 Pe-qualification warranty for Calls-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 retro reflective 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 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 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.

Item No. :- 49

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 coefficinnet on cemend road shalll 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.

803.4 Hot Applied Thermoplastic Road Marking**803.4.1 Thermoplastic Material****803.4.1.1 General**

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads. The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Engineer.

803.4.1.2 Requirements :

- I. 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 800-9.

Table 800-9 : 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 I nert Fillers	42.0max.	See Note Below
Yellow pigments	—	See Note Below

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.

- II. Properties: The properties of thermoplastic material, when tested in accordance with ASTM 036/BS-3262-(Part I), shall be as below:
 - a. Luminance:
 - White: Daylight luminance at 45°-65 percent min. as per AASHTO M249
 - Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M249
 - 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°C ± 9.5°C as per ASTM D 36.
 - f. 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 Clause 803.4.2.

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 manufacture
- 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 Engineer 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.

803.4.2 Reflectorizing Glass Beads

803.4.2.1 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 Table 800-9 and Type 2 beads are those which are to be sprayed on the surface vide Clause 803.6.4.

803.4.2.2 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 803.4.2.3.

803.4.2.3 Specific Requirements

- a) Gradation: The glass beads shall meet the gradation requirements for the two types as given in Table 800-10.

TABLE 800-10: GRADATION REQUIREMENT FOR GLASS BEADS

Sieve size	Percent 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		00 to 15

- b) Roundness : The glass beads shall have a minimum of 70 percent true spires.

- c) Refractive index : The glass beads shall have a minimum refractive 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 paints striping. They shall pass the free flow test.

803.4.2.4 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 dessicator which is filled within 25 mm of the top of a dessicator plate with sulphuric acid water solution (specific gravity 1.10). Cover the dessicator and let it stand for 4 hours at 20°C to 29°C. Remove sample from dessicator, 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 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:6088 and BS:3262 (Part I).
- iii. The Contractor shall furnish to the Engineer 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 these Specifications. However, if so required, these tests may be carried out as directed by the Engineer.

803.4.3 Application Properties of Thermoplastic Material

803.4.3.1 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.

803.4.3.2 The material upon heating to application temperatures shall not exude fumes which are toxic, obnoxious or injurious to persons or property.

803.4.4 Preparation

- i. The material shall be melted in accordance with the manufacturer's instructions in a heater 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.

803.5 Reflectorised Paint

Reflectorised paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Reflectorising glass beads for reflectorising paints where used shall conform to the requirements of Clause 803.4.2.

803.6 Application

803.6.1 Marking shall be done by machine. For locations where painting cannot be done by 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.

803.6.2 Where the compound is to be applied to cement concrete pavement, a sealing primer as 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 the markings are applied.

803.6.3 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.

803.6.4 The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line. Such new material shall so bond itself to the old line that no splitting or separation takes place.

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 metre area.

803.6.5 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).

803.6.6 The markings shall be done to accuracy within the tolerances given below:

- i. Width of lines and other markings shall not deviate from the specified width by more than 5 percent.
- ii. The position of lines, letters, figures, arrows and other markings shall not deviate from the position specified by more than 20 mm
- iii. The alignment of any edge of a longitudinal line shall not deviate from the specified alignment by more than 10 mm in 15 m.
- iv. The length of segment of broken longitudinal lines shall not deviate from the specified length by more than 150 mm.

In broken lines, the length of segment and the gap between segments shall be as indicated on the drawings; if these lengths are altered by the Engineer, the ratio of the lengths of the Painted sections shall remain the same.

803.6.7 Properties of Finished Road Markings

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.

- a. The stripe shall not be slippery when wet.
- b. The marking shall not lift from the pavement in freezing weather.
- c. After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures upto 60°C.

- d. The marking shall not deteriorate by contact with sodium chloride calcium chloride or oil dripping from traffic.
- e. The stripe 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

803.6.8 Measurements for Payment

803.6.8.1 The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any).

803.6.8.2 In respect of markings like directional arrows and lettering, etc., the measurement shall be by numbers.

803.6.9 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 drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work.

1.7 SPECIAL TERMS AND CONDITIONS FOR THERMOPLAST PAINT WORK:

- (1) Agency should carry out the such type of work by only of thermoplastic paint laying machine (power driven only) with temperature controller and automatic mixing arrangement of glass beads in required proportion.
- (2) After completion of the laying of thermoplastic paint work, four years guarantee for durability and reflectivity as per M.O.R.T.H. specification for road and bridge works clause 803 should be given by the bidder in the writing.
- (3) Guarantee security deposit shall be retained @ 10% of the cost of the item of thermoplast paint from the R.A. bills, which will be released after expiry of guarantee period.
- (4) Agency who carry out the such type of work shall have an experience of carrying out similar type of work.
- (5) Test certificates as per M.O.R.T.H. specification for road and bridge works clause 803.3.2.2 (vi) should be furnished of reputed laboratory before.

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Cat Eye / Road Stud / RPM: Supplying of Molded Twin Shanks Raised Pavement Markers made of polycarbonate and ABS moulded body and reflective panels with micro prismatic 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 strength of detachment of the integrated cylindrical shanks, (of diameter not less than 19 +/- 2 mm and height not less than 30 +/- 2 mm) from the body is to be a minimum value of 500 Kgf. 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 The color of the marker should be as per the IRC 35-2015 and as directed by Engineer- in-charge.

1.0 General

The colour, configuration, size and location of Molded Twin Shanks Raised Pavement Markers for highways other than Expressways shall be in accordance with the Code of Practice for Road Signs, IRC:35-2015 or as shown on the drawings or as directed by the Engineer.

The Molded Twin Shanks Raised Pavement Markers shall be reflectorised as shown on the drawings or as directed by the Engineer. It shall be of retro-reflectorised type and made of polycarbonate and ABS moulded body and reflective panels with micro prismatic 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.

In general, cautionary and mandatory signs shall be fabricated through process of screen printing. In regard to informatory signs with inscriptions, either the message could be printed over the reflective sheeting, or cut letters of non-reflective black sheeting used for the purpose which must be bonded well on the base sheeting as directed by the Engineer.

1.2 Materials :

The various materials and fabrication of the Molded Twin Shanks Raised Pavement Markers shall conform to the following requirements.

The adhesive materials shall be of standard quality and it shall be high resistance quality against heavy moving vehicles.

The materials shall be used for the body of the Molded Twin Shanks Raised Pavement Markers is of high density PVC materials.

The dimensions and size of the Molded Twin Shanks Raised Pavement Markers shall be as per IS standard. The retro-reflective sheeting used on the Molded Twin Shanks Raised Pavement Markers shall consist of the 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 show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests shall be obtained from a reputed laboratory, by the manufacturer of the sheeting. The reflective sheeting shall be either of Engineering Grade material with enclosed lens or of High Intensity Grade with encapsulated lens. The type of the sheeting to be used would depend upon the type, functional hierarchy and importance of the road.

High intensity grade sheetings : 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. 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 4280 Type H).

TABLE 800.1

ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING

[CANDEL AS PER LUX PER SQUARE METRE]

Observation (in degree)	Entrance angle (in degree)	White	Yellow	Orange	Green/Red	Blue
0.2	-4	250	170	100	45	20
0.2	+30	150	100	60	25	11
0.5	-4	95	62	30	15	7.5
0.5	+30	65	45	25	10	5.0

When totally wet, the sheeting shall not show less than 90 percent of the values of retro reflective indicated in Table 800-1. At the end of 7 years, the sheeting shall retain at least 75 percent of its original retro-reflectance.

Engineer grade sheetings : This sheeting shall be of enclosed lens type consisting of micro prismatic lens elements embedded beneath the surface of a smooth, flexible, transparent, water proof plastic, resulting in a non-exposed lens optical reflecting system. 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 4280 Type H) as indicated in Table 800.2.

TABLE 800.2

ACCEPTABLE MINIMUM CO-EFFICIENT OF RETRO-REFLECTION FOR HIGH INTENSITY GRADE SHEETING

[CANDEL AS PER LUX PER SQUARE METRE]

Observation (in degree)	Entrance angle (in degree)	White	Yellow	Orange	Green	Red	Blue
0.2	-4	70	50	25	9.0	14.5	4.0
0.2	+30	30	22	7.0	3.5	6.0	1.7
0.5	-4	30	25	13.5	4.5	7.5	2.0
0.5	+30	15	13	4.0	2.2	3.0	0.8

When totally wet, the sheeting shall not show less than 90 percent of the values of retro reflective indicated in Table 800-2. At the end of 5 years, the sheeting shall retain at least 50 percent of its original retro-reflectance.

1.3 Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, show no appreciable discolouration, cracking, blistering or dimensional change and shall not have less than 50 percent of the specified minimum reflective intensity values (Table 800-1 and 800-2) when subjected to accelerated weathering for 1000 hours, using type E or EH Weatherometer (AASHTO Designation M 268).

1.4 INSTALLATION:

The Molded Twin Shanks Raised Pavement Markers shall be installed directly on road surface, after cleaning completely by removing all dust and other foreign materials from the surface of the road.

1.5 MEASUREMENT FOR PAYMENT :

The measurement of Molded Twin Shanks Raised Pavement Markers shall be in numbers, these shall be measured in No.

1.6 RATE :

The Contract unit rate shall be payment in full for the cost of making Molded Twin Shanks Raised Pavement Markers including all materials, installing it at the site and incidentals to complete the work in accordance with the specifications.

1.0. Writing letter of figures on any surface with black Japan paint (stops, comas, hyphens and the like not to be measured and paid for separately) : block (Letters/figures). Materials 1.1. 2.0. 2.1. Ready mixed the black Japan paint shall conform to I.S. 341-1952. Workmanship The letters and figures shall be to the heights and widths as per approved drawings or as directed. These shall be stenciled or drawn in pencil and got approved before painting. They shall be of uniform size and finished neatly. The edges shall be straight or in pleasant smooth curves,

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Painting lines, deashes, arrows, letters etc on roads, Air fields and like in two coats with road marking paint, brushing including cleaning the surface of all dirt, dust and other foreign matter. (i) Over 10cm in width.

1.0. Materials

1.1. Ready mixed the black Japan paint shall conform to I.S. 341-1952.

2.0. Workmanship

2.1. The letters and figures shall be to the heights and widths as per approved drawings or as directed. These shall be stenciled or drawn in pencil and got approved before painting. They shall be of uniform size and finished neatly. The edges shall be straight or in pleasant smooth curves,

3.1. Mode of measurements and payment

Letters, figures and similar items etc. stops, commas, hyphens and the like shall be deemed to be included in the item. 9

3.2. The rate per cm. height of letter shall hold good irrespective of width of the letters of figures or the thickness of the lettering.

he relevant specifications shall be followed.

3.3. The rate shall be for a unit of One Sq. meter.

Hazard Marker Sign :- Providing and fixing sign boards made out of 2.0 mm aluminium sheet / 4 mm ACP (Aluminum composite Panel); size 90x30 cms. rectangular as per design of IRC-67-2012. Pre treated with phosphating 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 reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 1.8mtr long stand post of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol 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. (B) Class-B Type-4 Retro Reflective sheeting

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.

1.12 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 M-15 grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.27 REINFORCING STEEL

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

1.2.28 BOLTS, NUTS AND WASHERS

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

1.2.29 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.

1.2.30 SUBSTRATE

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

The mechanical proportion of ACM and that of aluminium 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 Aluminium Composite Material (ACM)

Sr. No.	Description	Specification for 4mm		Specification for 3 mm
		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.40N/mm ²	Min.30N/mm ²
3	0.2 % Proof Stress	ASTM E8	Min.34N/mm ²	Min.34N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5%
5	Flexural strength	ASTM C393	Min.130N/mm ²	Min.120N/mm ²
6	Shear strength with Punch shear	ASTM D732	Min.18 N/mm ²	Min. 18 N/mm ²
B	PROPERTIES OF ALUMINIUM SKING			
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

1.2.31 PLATE THICKNESS

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminium 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.

1.13 TRAFFIC SIGNS HAVING RETRO RELECTIVE SHEETING**1.13.1 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 or 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.

1.13.2 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 ^{oB}	-4°	300	200	120	54	54	24	14
0.1 ^{oB}	+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

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

^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 coefficient 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 ^{oB}	-4°	500	380	200	70	90	42	25	400	300	150
0.1 ^{oB}	+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

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

^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.

1.3.4. PRISMATIC GRADE SHEETING :

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-reflective for Type VIII 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°	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

Minimum Coefficient of Retro reflective (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 1 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-reflective for Type VIII 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
0.1°	-4°	80	60	30	8	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2	36	27	14

Minimum Coefficient of Retro reflective (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 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3. 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 800-6

Table 800-6 Acceptable Minimum Coefficient of Retro-reflective for Type VIII 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
0.1°	-4°	120	90	42	12	18	5	4	96	72	36
0.1°	+30°	45	34	16	5	7	2	1	36	27	14

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

^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 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 5mm. 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 percent of the corresponding value 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.

1.3.13 COLOR FOR SIGNS :

- 1.3.8.26. 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.
- 1.3.8.27. 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.
- 1.3.8.28. 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

Table 8.1 Specification Limits (Daytime)^A								
Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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

- 1.3.8.29. The mandatory and warning signs shall be provided with white background and red border. The legend / symbol for these signs shall be in black
- 1.3.8.30. The colours chosen for informator or guide signs shall be distinct for different categories of roads. For National Highway and State Highways, these signs shall be of green background with white border, 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 aluminium 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 sign 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 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 informant signs and definition plates.

1.8.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for National and State Highway and 100 mm for other roads. In case of overhead signs, the size ('x' height) of letters may be minimum 300mm. 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.

1.8.10.3 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.

1.8.11 WARRANTY AND DURABILITY :

The Contractor shall obtain from the original manufacturer of the Retro-Reflective sheeting for period of ten (7) 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 bounding 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 colour 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.

1.9 INSTALLATION :

1.4.1. The traffic signs shall be mounted on support posts, which may be of GI pipes which may be GI pipes conforming to IS 1239. Rectangular Hollow Section conforming to IS 4923 or square hollow section conforming to IS 589. 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 Specification 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 Unit shall be on number basis as applicable

1.6 RATE :

The contract unit rate shall be payment in full for the cost of making the road sign board, including all materials, labour charges, 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 or 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 retro reflective sheeting conforming 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 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 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.

Item No. :- 53

Four (Two) Lane Ahead Sign :- Providing and fixing sign boards made out of 2mm aluminium sheet / 4mm ACP (Aluminum composite Panel); size 120x120 cms. square plus 120x60cm additional plate as per design of IRC-67-2012. Pre treated with phosphating 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 reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; 4 mtr long stand post (2 Nos.) of Iron Angle 75 x 75 x 6mm / 65NB Circular MS Pipe as required and frame fabricated from suitable size iron angle of 35 x 35 x 3mm; painted with best quality epoxy coatings in black and white bends. The details of symbol 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. (B) Class-B Type-4 Retro Reflective sheeting

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.

1.14 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 M-15 grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.32 REINFORCING STEEL

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

1.2.33 BOLTS, NUTS AND WASHERS

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

1.2.34 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.

1.2.35 SUBSTRATE

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

The mechanical proportion of ACM and that of aluminium 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 Aluminium Composite Material (ACM)

Sr. No.	Description	Specification for 4mm		Specification for 3 mm
		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.40N/mm ²	Min.30N/mm ²
3	0.2 % Proof Stress	ASTM E8	Min.34N/mm ²	Min.34N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5%
5	Flexural strength	ASTM C393	Min.130N/mm ²	Min.120N/mm ²
6	Shear strength with Punch shear	ASTM D732	Min.18 N/mm ²	Min. 18 N/mm ²
B	PROPERTIES OF ALUMINIUM SKING			
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%	A50 Min. 2%
4	0.2 % Proof Stress	ASTM E8	Min.110 N/mm ²	Min.110 N/mm ²

1.2.36 PLATE THICKNESS

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminium 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.

1.15 TRAFFIC SIGNS HAVING RETRO REFLECTIVE SHEETING

1.15.1 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 or 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.

1.15.2 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 ^{OB}	-4°	300	200	120	54	54	24	14
0.1 ^{OB}	+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

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

^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 coefficient 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 ^{OB}	-4°	500	380	200	70	90	42	25	400	300	150
0.1 ^{OB}	+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

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

^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.

1.3.4. PRISMATIC GRADE SHEETING :

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-reflective for Type VIII 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°	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

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

^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 1 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-reflective for Type VIII 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
0.1°	-4°	80	60	30	8	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2	36	27	14

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

^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 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3. 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 800-6

Table 800-6 Acceptable Minimum Coefficient of Retro-reflective for Type VIII 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
0.1°	-4°	120	90	42	12	18	5	4	96	72	36
0.1°	+30°	45	34	16	5	7	2	1	36	27	14

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

^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 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 5mm. 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 percent of the corresponding value 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.

1.3.14 COLOR FOR SIGNS :

- 1.3.8.31. 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.
- 1.3.8.32. 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.
- 1.3.8.33. 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

Table 8.1 Specification Limits (Daytime)^A								
Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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

- 1.3.8.34. The mandatory and warning signs shall be provided with white background and red border. The legend / symbol for these signs shall be in black
- 1.3.8.35. The colours chosen for informator or guide signs shall be distinct for different categories of roads. For National Highway and State Highways, these signs shall be of green background with white boarder, legends and word messages. For Expressways these signs shall be of blue background with white boarder, legenes and word messages.

1.3.9 REFURBISHMENTS :

Where exisiting signs are specifired for refurbishments, the sheeting shall have semi-rigid aluminium 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 sign 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 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 informant signs and definition plates.

1.9.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for National and State Highway and 100 mm for other roads. In case of overhead signs, the size ('x' height) of letters may be minimum 300mm. 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.

1.9.10.3 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.

1.9.11 WARRANTY AND DURABILITY :

The Contractor shall obtain from the original manufacturer of the Retro-Reflective sheeting for period of ten (7) 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 bounding 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 colour 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.

1.10 INSTALLATION :

1.4.1. The traffic signs shall be mounted on support posts, which may be of GI pipes which may be GI pipes conforming to IS 1239. Rectangular Hollow Section conforming to IS 4923 or square hollow section conforming to IS 589. 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 Specification 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 Unit shall be on number basis as applicable

1.6 RATE :

The contract unit rate shall be payment in full for the cost of making the road sign board, including all materials, labour charges, 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 or 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 retro reflective sheeting conforming 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 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 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.

Kerb guard sign board (small) :-Providing & Fixing sign boards made out of 2mm aluminium sheet, size 240 x 30 cms in U shape; as per the attached drawing pre treated with phosphating 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 reflective sheeting of Type-4 as per ASTM D-4956 and latest M.O.S.T. Specifications; stand post and frame fabricated from iron angle of 50x50x5mm, 10mm sq. bar as required, painted with best quality epoxy coating the fixing at site shall be in 1:2:4 CC block of size 45 x 45x 60cms 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.

(B) Class-B Type-4 Retro Reflective sheeting

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.

1.16 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 M-15 grade as per section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

1.2.37 REINFORCING STEEL

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

1.2.38 BOLTS, NUTS AND WASHERS

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

1.2.39 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.

1.2.40 SUBSTRATE

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

The mechanical proportion of ACM and that of aluminium 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 Aluminium Composite Material (ACM)

Sr. No.	Description	Specification for 4mm		Specification for 3 mm
		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.40N/mm ²	Min.30N/mm ²
3	0.2 % Proof Stress	ASTM E8	Min.34N/mm ²	Min.34N/mm ²
4	Elongation	ASTM E8	Min. 6 %	Min. 5%
5	Flexural strength	ASTM C393	Min.130N/mm ²	Min.120N/mm ²
6	Shear strength with Punch shear	ASTM D732	Min.18 N/mm ²	Min. 18 N/mm ²
B	PROPERTIES OF ALUMINIUM SKING			
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

1.2.41 PLATE THICKNESS

Shoulder mounted ground signs with a maximum side dimension not exceeding 600 mm shall not be less than 1.5 mm thick Aluminium and 3 mm thick with Aluminium Composite Material. All other signs shall be at least 2mm thick Aluminium 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.

1.17 TRAFFIC SIGNS HAVING RETRO REFLECTIVE SHEETING**1.17.1 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 or 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.

1.17.2 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 rising 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 ^{oB}	-4°	300	200	120	54	54	24	14
0.1 ^{oB}	+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

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

^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 coefficient 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 ^{oB}	-4°	500	380	200	70	90	42	25	400	300	150
0.1 ^{oB}	+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

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

^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.

1.3.4. PRISMATIC GRADE SHEETING :

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-reflective for Type VIII 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 ^{OB}	-4°	1000	750	375	100	150	45	30	800	600	300
0.1 ^{OB}	+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

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

^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 1 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-reflective for Type VIII 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 ^{OB}	-4°	660	500	250	66	130	30	530	400	200
0.1 ^{OB}	+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
0.1°	-4°	80	60	30	8	16	3.6	64	48	24
0.1°	+30°	45	34	17	4.5	9.0	2	36	27	14

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

^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 10 years, the sheeting shall retain at least 80 percent of its original retro-reflectance.

1.3.4.3. 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 800-6

Table 800-6 Acceptable Minimum Coefficient of Retro-reflective for Type VIII 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
0.1°	-4°	120	90	42	12	18	5	4	96	72	36
0.1°	+30°	45	34	16	5	7	2	1	36	27	14

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

^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 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 5mm. 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 coefficient

of retro-reflection shall not be less than 50 percent of the corresponding value 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.

1.3.15 COLOR FOR SIGNS :

- 1.3.8.36. 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.
- 1.3.8.37. 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.
- 1.3.8.38. 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

Table 8.1 Specification Limits (Daytime) ^A								
Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green ^B	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Blue ^B	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355

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

- 1.3.8.39. The mandatory and warning signs shall be provided with white background and red border. The legend / symbol for these signs shall be in black
- 1.3.8.40. The colours chosen for informant or guide signs shall be distinct for different categories of roads. For National Highway and State Highways, these signs shall be of green background with white boarder, legends and word messages. For Expressways these signs shall be of blue background with white boarder, legenes and word messages.

1.3.9 REFURBISHMENTS :

Where exisiting signs are specifired for refubishments, the sheeting shall have semi-rigid aluminium 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 sign 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 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 informant signs and definition plates.

1.10.10.2 For advance direction signs on non-urban roads, the letter size ('x' height) should be minimum of 150 mm for National and State Highway and 100 mm for other roads. In case of overhead signs, the size ('x' height) of letters may be minimum 300mm. 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.

1.10.10.3 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.

1.10.11 WARRANTY AND DURABILITY :

The Contractor shall obtain from the original manufacturer of the Retro-Reflective sheeting for period of ten (7) 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 bounding 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 colour 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.

1.11 INSTALLATION :

1.4.1. The traffic signs shall be mounted on support posts, which may be of GI pipes which may be GI pipes conforming to IS 1239. Rectangular Hollow Section conforming to IS 4923 or square hollow section conforming to IS 589. 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 Specification 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 Unit shall be on number basis as applicable

1.6 RATE :

The contract unit rate shall be payment in full for the cost of making the road sign board, including all materials, labour charges, 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 or its subsidiary. In India. Certificate issued by distributor dealer / power fo 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 Pe-qualification warranty for Calls-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 retro reflective 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 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 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.

Item No. : 55

Supply & fixing Jumbo bollard Swiss type: Made out of 1.5mm croc sheet, height 188cms, Bottom diameter 30cms. Top diameter 18cms with direction plate of 45cms diameter, fabricated as per attached drawing. Pre treated with phosphating process, painted with epoxy coatings. Reflectorised with retro reflective sheeting's specified by M.O.S.T's specifications. (B) High Intensity Grade.

Work :

The work shall consist of fitting Jumbo Bollard swiss type on end of divider or specified by Engineer in charge with proper measurement laid out in specification.

Material :

Jumbo bollard swiss type shall be made out from 1.5 mm MS sheet with height of 188 cm bottom diameter of 30 cms and Top diameter 18 cm with direction plate at top of 45 cm dia. MS plate used shall be pretreated with phosphating process and painted with epoxy coating. Bollard shall be reflectorised with retro reflective sheeting. Conforming to MORTS specification clause 804 & IRC 73.

Workmanship :

Jumbo bollard shall be fixed at specified location as per drawing or instruction of Engineer in charge. Bollard shall be fixed in concrete or bolted with proper caution. So that it can not be easily removed.

Measurement/ Rate :

Item shall be measured in Nos. basis.

Item No. : 56

Road Delineators (Supplying and installation of delineators (road way indicators, hazard markers, object markers), 80-100 cm high above ground level, painted black and white in 15 cm wide stripes, fitted with 80 x 100 mm rectangular or 75 mm dia circular reflectorised panels at the top, buried or pressed into the ground and conforming to IRC-79 and the drawings.)

General :

The work covers supplying and fixing roadway indicators, hazard markers and object markers

The design, materials to be used and the location of the road delineators shall conform to Recommended Practice for Road Delineators, IRC:79, and to relevant drawings or as otherwise directed by the Engineer.

Measurement for Payment :

The measurement shall be made in numbers of delineators fixed at site.

Rate :

The contract unit rate for road delineators shall be payment in full compensation for furnishing all labour, materials, tools, equipment for preparing supplying and fixing at site and all other incidental costs necessary to complete the work to these Specifications.

Item No. :- 57

Anti-Glare screen: Providing and erecting Safety Light Barrier Anti-Glare screen of dimension 1335 mm x 600 mm x 80 mm leaf shape of High durable virgin premium grade Polyethylene material (L.L.D.P.E.) resistant to wind load 6m/s, and good aging resistance. The fixing at site shall be in 1:2:4 CC block of size 30 x 30 x 40 Cms by drilling of 30 cm x 30 cm x 30 cm size in existing median and anchoring by 2 nos of 8 mm Dia Fe 500 D Reinforcement Bar and Fixing Radium strip of 225 mm x 215 mm size both side including excavation, curing etc. complete Block for proper level and smooth surface below the ground and anti glare screen having clear the 1600mm height over the ground at every 1.5m c/c spacing. INCLUDING Labour Charges Fitting and Transportation at site. All Installation, fitting and material be as per instruction approved by the engineer in charge at site

- 1335 mm (width) x 600 mm (height) x 80 mm (depth).
- Leaf-shaped design.
- Material: High durable virgin premium grade Polyethylene (L.L.D.P.E.)
- resistant to wind load (6 m/s) and has good aging resistance.

2. Installation:

- Fixing: At the site, the screen is to be fixed in a 1:2:4 Concrete (CC) block with dimensions 30 cm x 30 cm x 40 cm
- Excavation of 30 cm x 30 cm x 30 cm for the foundation
- Reinforcement: Anchored by two 8 mm diameter Fe500 D Reinforcement Bars.
- Reflective Strips: Class-B Retro-Reflective type radium strips (50 mm x 50 mm) to be fixed on both sides for visibility.

3. Height and Spacing:

- The screen should be installed with a clear height of 1600 mm above the ground.
- Screens to be installed at 2-meter centre-to-centre spacing.

4. Labor and Other Charges:

- Labour charges for fitting and transportation to the site. Curing of the concrete is included.
- All installations and materials should follow the instructions approved by the engineer in charge

5.Measurement:

- The rate shall be for a unit of one Nos.

Item No. :- 58

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.

810.1. General

810.1.1. This work shall consist of furnishing and erection of metal beam crash barrier of dimensions and at locations as shown on the drawing (s) or as directed by the Engineer.

810.1.2. Metal beam crash barrier shall generally be located on approaches to bridge structures, at locations where the embankment height is more than 3 metres and at horizontal curves.

810.2. Materials

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

810.2.2. Steel beam elements and terminal sections shall be galvanised (zinc coated, 0.55 kg per square metre, minimum single spot) unless otherwise specified. The galvanising 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.

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

810.3. Construction Operations

810.3.1. 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.

810.3.2. 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 galvanised. Any part of assembly below ground shall be painted with three coats of red lead paint.

810.3.3. 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.

810.4. Installation of Posts

810.4.1. 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.

810.4.2. 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.

810.4.3. 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.

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

810.4.5. Posts for metal beam guardrails 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.

810.5. Erection

810.5.1. All guardrail anchors shall be set and attachments made and placed as indicated on the plans or as directed by the Engineer.

810.5.2. 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.

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

810.6. Tolerance

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

810.7. Measurements for Payment

810.7.1. 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.

**Executive Engineer
Road & Building Division
PORBANDAR**