

PAVEMENT DESIGN OF KARCHELIYA-DEDVASAN ROAD-A DPR BASED APPROACH

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Abstract: This paper involves widening and strengthening of road network starts from Karcheliya-Bartaad -Kharvan-Dedvasan in Mahuva Taluka, Surat District, and Gujarat. The path is 0/0 to 9/45 km long and 3.75 m wide at present. The proposed width of the road is to convert the existing road from 3.75 m to 7.00 m. The work includes topographic survey, geotechnical investigations, traffic survey, earthwork calculations, geometric design of elements, drainage design and protection wall required as per standards to prepare a detailed project report. The soil of the area consists of black cotton soil that needs stabilization by using admixtures. The outcome of the study improves the strength and drainage condition of the road as well as the smooth flow of vehicles as a part of our study. The cost of overall road section is Rs.7,55,70,168.04.

Keywords: WBM, black cotton clayey soil, drainage, cross section, longitudinal section, earthwork.

I. INTRODUCTION

The Karcheliya-Dedvasan road is located in the district of Surat, which in turn is located in the State of Gujarat. The road chainage is 0/0 to 9/45 km, which passes through Karcheliya, Kharvan, Bartad and Dedvasan.

The project road which has length of about 9.45 km, passes through plain terrain with fertile Agricultural land on either side. Thus, the project besides facilitating the commuting traffic and fostering agricultural development, will serve as a high-speed link.



Figure 1 Location of the road

II. AIM AND OBJECTIVES

AIM:

To prepare planning proposal for design and development of Karcheliya-Dedvasan road in Mahuva.

OBJECTIVE:

The prime objective is to establish the technical, environmental and social viability of the project for developing the existing Karcheliya-Dedvasan road section. The viability of the project designed as partially access controlled facility will be established taking into account the requirements with regard to rehabilitation, upgrading and improvements based on pavement design, type of intersections, rehabilitation and widening of project.

III METHODOLOGY

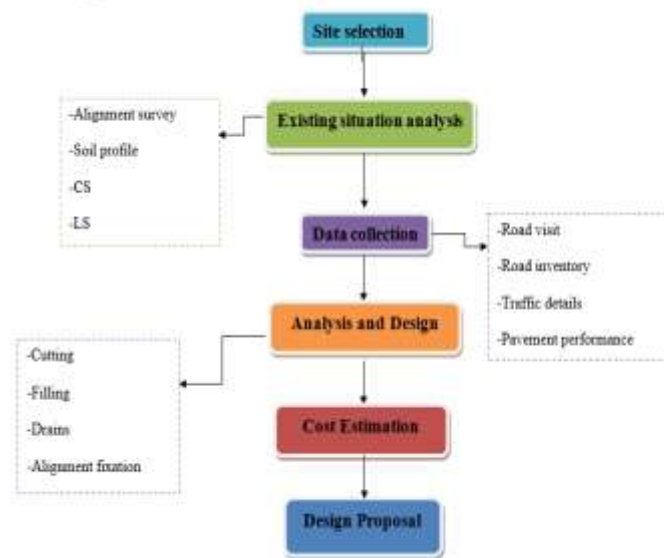


Figure 2 Methodology

The methodology involves intensive studies of different components in consultation with the authority and residents, analyzing data to be obtained from various departments related to the development process and design proposal of road.

IV STUDY AREA PROFILE

Mahuva taluka, Surat district located in Gujarat is connected by roads and public bus transport services to Bardoli, Navsari, Surat, Ahmedabad and Saputara. Nearest Western Railway stations are Navsari about 20 km, Surat about 55 km and Bardoli about 20 km.

Latitude- longitude of the Mahuva is given below:

Mahuva	21° 10' N	71° 45' E
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V DATA COLLECTION AND ANALYSIS

A.SOIL AND MATERIAL SURVEY

Soil samples were collected along and around the road alignment at five locations per 2 km, from the adjoining borrow area. Soil Classification tests like grain size analysis and Atterberg's limit were conducted for all the samples. Standard Proctor test and the corresponding CBR test were also conducted.



Figure 3 Location of soil sample

[Refer table 1](#)

B.TRAFFIC SURVEY

Traffic survey was carried out at intersection of Karcheliya – Kharvan road.

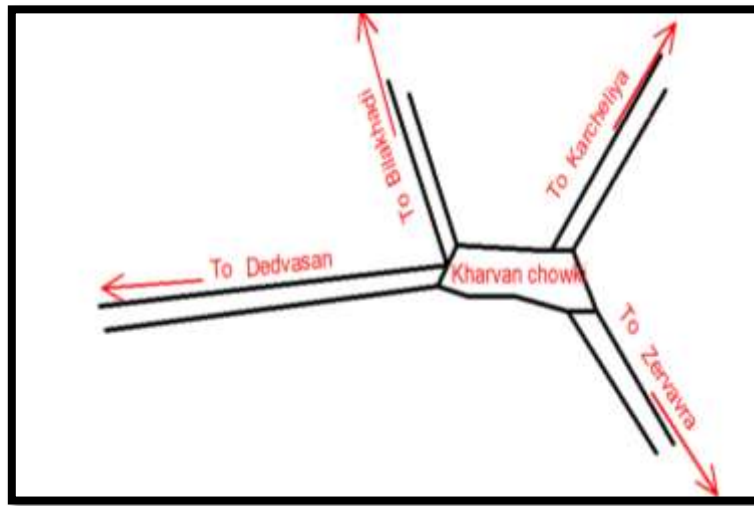


Figure 4 KharvanChowki

[Refer table2](#)

Traffic data and analysis

The traffic count done was classified into different vehicle category as given below:

1. Motorized vehicle comprising of light commercial vehicle, medium commercial vehicle, heavy commercial vehicle, trucks, buses, agricultural tractors with trailers, car and two wheelers.
2. Non- motorized vehicles comprising of cycle, rickshaw, cycle van and animal drawn vehicle

Average of 3 day traffic data is presented in TABLE 2. In concern of road crust designing we have considered only cars, luv and mov.

C.TACHEOMETRIC SURVEY

Topographic survey true to ground realities have been done using precision instruments like total stations and auto levels, and bringing out data in digital form (x, y, z format) for developing digital terrain model (DTM).

The in-house standards, work procedures and quality plan prepared with reference to IRC: SP 20 and current international practices have been followed during the above survey.

Data Processing

All data from topographic survey recorded and final alignment, plan, profile were prepared and presented in AutoCAD Format.

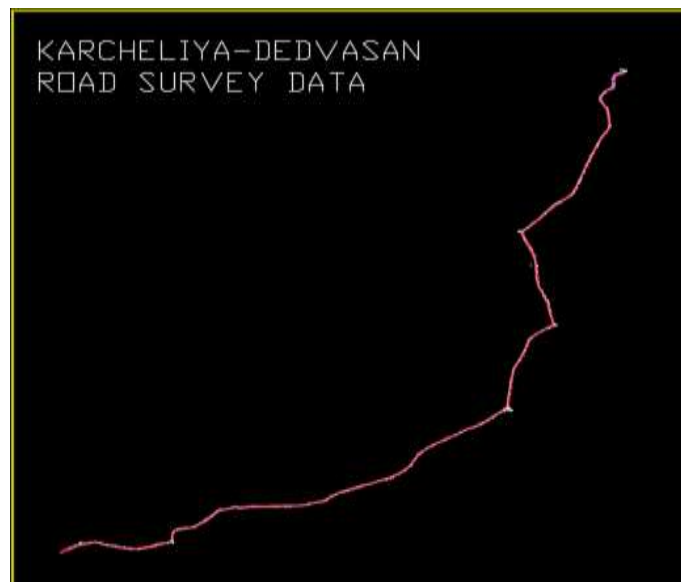


Figure 5 Road Plan



Figure 6 Total station survey

VI DESIGN PROPOSAL

A.ADOPTED GEOMETRIC DESIGN

The geometric design for the flexible pavement was adopted with reference to IRC-37“Guidelines for the design of flexible pavement.”

1. Terrain

The road Karcheliya-Dedvasan is of plain terrain category as cross slope is more than 1 in 10 according to the longitudinal section.

2. Design Speed

For the plain terrain proposed design speed is

Road classification	Plain terrain	
	Ruling	Min.
Rural Roads (ODR and VR)	50	40

3. Right Of Way (ROW)

The requirement of ROW for this road is as follows (as specified in IRC-SP 20:2002):

Road classification	Plain and Rolling Terrain	
	Open Area	Built-up Area
MDR	25	20

4. Carriageway Width

The width of carriageway for this project road is 7.5m. The width may be restricted to 7.0 m.

5. Shoulders

It is proposed to have 1 m wide shoulder water bound macadam material on both sides of carriageway.

6. Roadway Width at Cross-Drainage Structures

The roadway width at culvert locations for this road is 7.5 m in plain terrain.

7. Side Slope

Side slope for this major district road where embankment height is less than 3m is taken as 1.5:1.

B.PAVEMENT DESIGN

Considering the subgrade strength, projected traffic and the design life, the pavement design for low volume major district roads (MDR) was carried out as per guidelines of IRC: 37 “Guidelines for the design of flexible pavement.” and “MORT&H Specifications –Ministry of Road Transport & Highways”.

Pavement Design Approach

1 Design Life

A design life of 15 years was considered for the purpose of pavement design of flexible pavements of the proposed road.

2. Design Traffic

For the purpose of structural design, only the number of commercial vehicles of gross vehicle weight of three tons or more and their axle-loading is considered.

3.Traffic growth rate

For inadequate data, it is recommended that an average annual growth rate of 7.5 % may be adopted.

For the design of Karcheliya-Dedvasan road is taken as 7.5%.

4.Vehicle damage factor

From the data of traffic, the VDF is taken as 1.5 for the road as traffic is less than 150 cvpd.

5.Distribution of commercial traffic over the carriageway

As the road is “Two-lane single carriageway roads”-The design should be based on 75 per cent of the total number of commercial vehicles in both directions.

Cumulative Traffic

$$N = \frac{365 [(1+r)^n - 1]}{r} \times A \times D \times F$$

N = the cumulative number of standard axles to be catered for in the design in terms of m.s.a.

A= Initial traffic in the year of completion of construction in terms of the number of commercial vehicles per day

D = Lane distribution factor

F = Vehicle damage factor

n = Design life in years

r = Annual growth rate of commercial vehicle (generally taken as 7.5 percent)

Anticipated traffic

$$A = P (1+r)^x$$

P = Number of commercial vehicles as per last count

X = Number of years between the last count and the year of completion of construction

[Refer table3](#)

VII ESTIMATION

Basic Rates

[Refer table 4](#)

Estimate for Road Construction

[Refer table 5](#)

VIII CONCLUSION

CONCLUDING REMARKS

To fulfill the aim of widening the existing road from 3.75m to 7.00m with 1m unpaved graded shoulder, different tests were performed that include Atterberg’s limit, free swell index, specific gravity, modified proctor test, and California

bearing ratio. Traffic survey of three hour was done for calculation of msa. Using those data, design of crust design is carried out. At certain points where CBR value is lower than specification given by IRC 37 needs improvement by lime stabilization.

Using tachometric survey with total station cost estimation, quantity estimation and geometry aspects are carried out. Mid-sectional area method is used to calculate the total earthwork required for 50m interval. Total earth work requires is **37,634.87 m³**. Estimated cost is worked out as **7,55,70,168.04INR** wherein the rate includes transportation cost of material, its lying on site, labour charge and contractor's profit.

IX LIMITATIONS

According to IRC-37, soil sample for performing CBR test should be taken for every 200m interval; but due to limitation of resources, the samples are taken for every 2km.

For analyzing the strength of road and thickness of each crust, two methods are adopted.

1) Core cutter method; 2) Trial pit method

With observations and general analysis, no lacking sign in strength is observed. Hence, these both methods are eliminated.

According to IRC-37, traffic survey is required of 24 hours for 3 days. Traffic data were collected from R & B Department for 3 days 24 hours and 1 hour survey was done for comparing and calibrating the data.

APPENDIX

Tables are as following;

Item No.	Test Name		Unit	Sample-1	Sample-2	Sample-3	Sample-4	Sample-5	Method of testing
1.	Atterberg's limit	Liquid Limit	%	33.176	18.75	44.86	39.58	41.98	I.S.2720-(Part 5)-1985 (Reaffirmed 1995)
		Plastic Limit	%	17.28,21.51	20.56,18.83	27.8	17.92	14.65	
2.	Grain size Analysis	Gravel (> 4.75mm)	%	8.7	11.27	8.31	6.88	3.64	I.S. 2720 (Part 4)-1985 (Reaffirmed 1995)
		Sand(4.75-0.075mm)	%	41.86	47.49	54.96	52.5	22.89	
3.	Modified Proctor Density	Maximum dry density	gm/cc	1.751218	1.746428	1.656106	1.769308	1.629587	I.S. 2720 (Part 8)-1985 (Reaffirmed 1995)
		Optimum Moisture Content	%	17.00431	14.86304	18.83295	18.57741	22.48506	
4.	Free Swell Index		%	9.09	18.18	20	20	27.27	I.S. 2720(Part 40)-1997 (Reaffirmed 1997)
5.	Specific Gravity			2.5	2.23	2.5	2.25	2.10	I.S. 2720 (Part-3/Sec-1)
6.	C.B.R.(Soaked)		%	3.85	15.79	1.28	1.6		I.S. 2720(Part 16)-1987 (Reaffirmed 1997)

Table 1 Soil and Material Survey

	Monday		Saturday		Sunday	
	Karcheliya	Kharvan	Karcheliya	Kharvan	Karcheliya	Kharvan
Time	Heavy vehicles (Nos.)					
7 a.m. to 8 a.m.	5	4	4	-	3	3
8 a.m. to 9 a.m.	2	3	4	3	5	3
9 a.m. to 10 a.m.	4	5	7	7	6	4
10 a.m. to 11 a.m.	3	4	8	7	5	6
11 a.m. to 12 p.m.	6	7	6	7	7	4
12 p.m. to 1 p.m.	6	6	7	6	4	6
1 p.m. to 2 p.m.	3	2	6	3	5	4
2 p.m. to 3 p.m.	2	3	4	3	4	6
3 p.m. to 4 p.m.	5	6	5	5	6	8
4 p.m. to 5 p.m.	6	7	6	7	5	6
5 p.m. to 6 p.m.	5	8	5	6	6	5
6 p.m. to 7 p.m.	6	7	7	7	4	5
7 p.m. to 8 p.m.	5	4	5	7	4	3
8 p.m. to 9 p.m.	6	5	4	4	3	1
9 p.m. to 10 p.m.	2	2	3	6	2	2
10 p.m. to 11 p.m.	2	2	1	-	-	-
11 p.m. to 12 a.m.	-	-	-	-	1	1
12 a.m. to 1 a.m.	-	-	-	-	-	-
1 a.m. to 2 a.m.	-	-	-	-	-	-
2 a.m. to 3 a.m.	-	-	-	-	-	-
3 a.m. to 4 a.m.	-	-	-	-	1	-
4 a.m. to 5 a.m.	-	-	-	-	1	1
5 a.m. to 6 a.m.	1	1	2	2	3	3
6 a.m. to 7 a.m.	3	3	3	1	5	4
Total	72	79	87	81	80	75

Table 2 Traffic Survey

Sections	Distance (m)	CBR value	Cumulative Traffic (msa)	Total Pavement Thickness (mm)	Pavement composition			
					Bituminous Surfacing		Granular Base(mm)	Granular Sub-base(mm)
					Wearing course(mm)	Binder course (mm)		
1	1836.09	3.85	1	490.5	20 PC	-	225	282
2	1698.72	2.14*	1	660	20 PC	-	225	435
3	2221.5	2.14*	1	660	20 PC	-	225	435
4	3608.57	2.14	1	644.6	20 PC	-	225	435
5	802.975	9.82	1	375	20PC	-	225	150
6	849.36	8.60	1	375	20PC	-	225	150
7	1110.75	1.44	1	660	20PC	-	225	435
8	1804.28	1.87	1	660	20PC	-	225	435
9	949.71	1.76	1	660	20PC	-	225	435
10	854.57	2.00	1	660	20PC	-	225	435

(*actual CBR is below 2% which is taken as 2.14% with lime stabilization)

Table 3 Pavement Design

Sr .	Material	Unit	Basic Rates (INR)	Loading (INR)	Unloading (INR)	Lead (INR)	Conveyance Charges (INR)	Conveyance cost (INR)	Total (INR)
1	Coarse Sand	m ³	234	25.5	15.17	40	8.49	339.6	614.27
2	Fine Sand	m ³	234	43.47	15.17	40	8.49	339.6	632.24
2	Rubble	m ³	148	43.47	15.17	40	9.75	390	596.64
3	Crushed stone (Hard quality) Agg. 50mm	m ³	293	43.47	15.17	40	7.08	283.2	634.84
4	Crushed stone (Hard quality) Agg. 40 mm	m ³	319	43.47	15.17	40	7.08	283.2	660.84
5	Crushed stone (Hard quality) Agg. 25mm	m ³	366	43.47	15.17	40	6.54	261.6	686.24
6	Crushed stone (Hard quality) Agg. 20mm	m ³	413	43.47	15.17	40	6.54	261.6	733.24
7	Crushed stone (Hard quality) Agg. 10mm	m ³	390	43.47	15.17	40	6.54	261.6	710.24
8	Crushed stone (Hard quality) Agg. 6mm	m ³	285	43.47	15.17	40	6.54	261.6	605.24
9	Close graded Granular sub-base material 2.36mm	m ³	450	43.47	15.17	40	7.08	283.2	791.84
10	Close graded Granular sub-base material 4.75-2.36mm	m ³	450	43.47	15.17	40	7.08	283.2	791.84
11	Close graded Granular sub-base material 9.5-2.36mm	m ³	500	43.47	15.17	40	7.08	283.2	841.84
12	Close graded Granular sub-base material 9.5-4.75mm	m ³	500	43.47	15.17	40	7.08	283.2	841.84
13	Close graded Granular sub-base material 26.5-9.5mm	m ³	600	43.47	15.17	40	7.08	283.2	941.84
14	Close graded Granular sub-base material 53-9.5mm	m ³	600	43.47	15.17	40	7.08	283.2	941.84
15	Murum/Binding material	m ³	64	43.47	15.17	5	8.49	0	122.64
16	Cement	MT	4756	100.17	100.17	40	4.57	182.8	5139.14
17	Stone dust	m ³	105	43.47	15.17	40	8.49	339.6	503.24
18	Un-screened Gravel	m ³		43.47	15.17	5	8.49	0	58.64
19	Screen Gravel	m ³		43.47	15.17	5	8.49	0	58.64
20	Stone spall	m ³	120	43.47	15.17	40	8.49	339.6	518.24
21	bitumen Emulsion	MT	43000	125.17	110.6	40	5.59	223.6	43,459.37

Table 4 Basic rates

Sr. No	Description of Item	Length (m)	Width (m)	Thickness (m)	Unit	Quantity	Rate (INR)	Amount (INR)
1	Clearing and Grubbing road land including uprooting wild vegetation, grass, bushes, shrubs, saplings and trees of girth up to 300 mm, removal of stumps of such trees cut earlier and disposal of unserviceable materials (C) By mechanical means in area of light jungle (Item code-26117C,pg.253,R&B SOR Surat City, Govt. Gujarat)	7937 (negligible deduction length)	6		Hectare	47622 m ² 47.622 hectare	31739.00	1511474.65
2	Scarifying Existing Bituminous Surface to a Depth of 50 mm by Mechanical Means (Item code-26063, pg.224,R&B SOR Surat City, Gov.Gujarat)	7937-387 (RCC paved road)-8*4 (8 culverts of 4m length)	3.75		m ²	7518	25.60	192460.8
3	Earthwork for embankment including breaking clods, dressing with all lead and lift and including watering rolling and consolidation of subgrade in layers at O.M.C. to required dry density including filling the depression which occur during the process using power roller 8T to 10T.(B) From Borrow area within 0.5KM lead(more than 10 ton) (Item code-26004BA, pg.211,R&B SOR Surat City, Gov.Gujarat)				m ³	37634	167.00	6284878
4.	Granular sub-base Supplying of crushed aggregate, chipping, of hard stone of following nominal size free of disintegrated pieces of deleterious and organic matter (for bitumen surface dressing.) and grading as per IRC Code(i) 50mm	-	-	-	m ³	7076.74	634.00	4486653.16
5	Granular sub-base Supplying of crushed aggregate, chipping,. of hard stone of following nominal size free of				m ³	11121	723.00	8154362.04

	disintegrated pieces of deleterious and organic matter (for bitumen surface dressing and grading as per IRC Code(iv) 20mm							
6	Granular sub-base Supplying of crushed aggregate, chipping of hard stone of following nominal size free of disintegrated pieces of deleterious and organic matter (for bitumen surface dressing and grading as per IRC Code(vii)6mm				m ³	2012.8	605	1217744
7	Granular base Supplying of crushed aggregate, chipping of hard stone of following nominal size free of disintegrated pieces of deleterious and organic matter (for bitumen surface dressing) and grading as per IRC Code(i) 40mm				m ³	1707	660.84	1128053.88
8	Granular base Supplying of crushed aggregate, chipping of hard stone of following nominal size free of disintegrated pieces of deleterious and organic matter (for bitumen surface dressing)and grading as per IRC Code(i) 25mm				m ³	1707	686.64	1171411.68
9	Granular base Supplying of crushed aggregate, chipping, of hard stone of following nominal size free of disintegrated pieces of deleterious and organic matter (for bitumen surface dressing) and grading as per IRC Code(i) 20mm				m ³	1514	733.24	1110125.36
10	Granular base Supplying of crushed aggregate, chipping of hard stone of following nominal size free of disintegrated pieces of deleterious and organic matter (for bitumen surface dressing) and grading as per IRC Code(i) 10mm				m ³	1514	710.24	1075303.36
11	Granular base Supplying of crushed aggregate, chipping, of hard stone of following nominal size free				m ³	1514	605.24	916333

	of disintegrated pieces of deleterious and organic matter (for bitumen surface dressing) and grading as per IRC Code(i) 06mm							
12	Provide stone dust of grade 2.36mm to 75 micron				m ³	3415.45	503.24	1718797.57
13	Laying , dressing and compaction of granular sub base and granular base of all considered size				m ³	11384.85+20218.97=31603.82	554	17508516.28
14	Providing and supplying evenly priming and tack coat with bitumen 10kg/m ² (including heating the bitumen but excluding the cost of bitumen)				m ²	55559	4.20	233347.8
15	Preparing surface by brushing with wire brushes for removing caked mud sweeping with brooms and finally fanning the clean surface with gunny bags to remove all loose dust.				m ²	55559	11.00	611149
16	Bituminous rate per metric ton				MT	555.59	43000	23890370
	Total				IN R			71210976.58

Sr. No.	Description of item	Unit	Quantity	Rate (INR)	Amount (INR)
16	Cautionary warning Sign: Providing and fixing sign boards made 2mm aluminium sheet; size 450x450mm, equilateral triangle as per IRC-67-1977. Pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with retro reflective sheeting as per latest M.O.S.T. specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35x35x3mm, 75x75x6m as required; 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 blocks of size 45x45x60 Cms. For each leg, including excavation, curing, complete supervision of engineer in charge. (A) Engineer Grade..... (Item code-26092B, pg.231, R&B SOR 015-16, Gov. Gujarat)	No	30	3486.00	104580
17	Informatory Sign: Providing and fixing sign boards made 2mm aluminium sheet; size 80x60cm, rectangle as per IRC-67-1977. Pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with retro reflective sheeting as per latest M.O.S.T. specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35x35x3mm, 75x75x6m as required; 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 blocks of size 45x45x60 Cms. For each leg, including excavation, curing, complete under the supervision of engineer in charge. (A) Engineer Grade..... (Item code-26093A, pg.231, R&B SOR 015-16, Gov. Gujarat)	No	21	3033.00	63693
18	Regulatory/Mandatory Sign: Providing and fixing sign boards made 2mm aluminium sheet; size 60cm diameter as per IRC-67-1977. Pretreated with phosphating process & acid etching; coated with one coat of epoxy primer and two coats of best quality epoxy paint; reflectorized with retro reflective sheeting as per latest M.O.S.T. specifications; 3.1m long stand post and frame fabricated from suitable size iron angle of 35x35x3mm, 75x75x6m as required; 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 blocks of size 45x45x60 Cms. For each leg, including excavation, curing, complete under the supervision of engineer in charge. (A) Engineer Grade.....	No	14	2546.00	35644

	Charge.(A) Engineer Grade..... (Item code-26094A, pg.232,R&B SOR 015-16, Gov.Gujarat)				
19	Direction Sign: Providing and fixing sign boards made 2mm aluminum sheet; size rectangle as per IRC-67-1977.Pretreated etching process & acid etching; coated with epoxy primer and two coats of best y paint; reflectorized with retro reflective per latest M.O.S.T. specifications; Letters s should be as per IRC-30-1968 3.1m stand post and frame fabricated from iron angle of 35x35x3mm,75x75x6mm as nted with best quality epoxy coatings in white bends. The details of symbol or umerals for each board shall be as per the of engineer in charge. The fixing at site 1:2:4 CC blocks of size 45x45x60 Cms. eg. Including excavation, curing etc. der the supervision of engineer in charge. er Grade..... (Item code-26098A, pg.236,R&B SOR 015-16, Gov. Gujarat)	No	6	12153.00	72918
20	Kilometer Stone Reinforced cement concrete M15 grade one/local stone of standard design as per in position including painting ,etc as per other specification (A) Ordinary kilometer stone	No	10	714	7140
	Total of all quantities above				7,14,94,955.58
Tax	Swatch Bharat Mission Tax		0.2%		1,42,989.91
	Labourcess		1%		7,14,94,9.55
	Service Tax		4.5%		32,17,273.00
	TOTAL				7,55,70,168.04

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