HIGHWAY DESIGN PROJECT REPORT

Introduction

The introduction should be written in English. In this section a short description of project must be presented which includes; data and information used for the project, brief definition of applications and calculations made, special cases or assumptions if any exists. Introduction length is expected to be 400-600 words length.

1. Design Traffic Calculation and Selection of Highway Geometric Standards

T_0 = 650000 veh
Percentage of heavy vehicle = 14% (10 + The digit before last digit of student number)
Percentage of passenger car = 100% - 14% = 86%
1 heavy vehicle = 2 passenger car units
$T_0 = 650000*(0.86*1+0.14*2) = 741000$ pcu/year

$T_n = T_0*(1+r)^n$
r = 2% (The last digit of student number)
Service life: 20 years
$T_{20} = 741000*(1+0.02)^{20} = 1101087$ veh/year

$$\text{AADT} = \frac{1101087}{365} = 3016,7 = 3017 \text{ pcu/day}$$

Daily Hour Traffic = Annual Average Daily Traffic * K

$$K = \frac{1}{6}$$

$$\text{DHT} = \frac{3017}{6} = 502.8 \approx 503 \text{ pcu/hr}$$

DHT = 503 < 800 pcu/hr, so 3rd class highway is selected.

Straight distance between endpoints = 618.22 m
Elevation difference between endpoints = 50 m

$$\text{Straight line slope} = \frac{50}{618.22} = 0.081 = 8.1\%$$

Design Traffic (pcu/hr)	: 503 pcu/hr
Topography	: Undulating
Design Speed (km/hr)	: 60 km/hr
Min. Horizontal Curve Radius (m)	: 200 m
Min. Crest Vertical Curve Radius (m)	: 5000 m
Min. Sag Vertical Curve Radius (m)	: 2000 m
Max. Grade (%)	: 8%
Max. Super-elevation (%)	: 8%
Crossfall (%)	: 2%
Lane Width (m)	: 3 m

Shoulder Width (m)	: 1 m
Carriageway Width (m)	: 8 m
Right-of-Way Width (m)	: 20 m

2. Calculations about zero polygon

Max. grade for 3rd class highways on undulating topography is 8%.,
Straight line slope = 8.1% > 8%
Slope = 8%

1st zero polygon study, radius = $\frac{5}{8\%} = 62.5\,\text{m}$

Zero polygon is 525m behind, so new radius = 62.5 + 525/10 = 115m

2nd zero polygon study, radius = 115m

Zero polygon is 49m behind. So last compass radius is increased to 164m and zero polygon reached to the endpoint.
Last compass slope = 5/164 = 3%

3. Calculations of Route Survey and Horizontal Curves

Calculations of all horizontal curves (Δ, R, t, L_c and e) on the route should be written in detail.

$\Delta = 139.89°$
R = 200 m

$$T = 200 * \tan(\frac{139.89°}{2}) = 547.86\,\text{m}$$

$T_{measured}$ = 547.90 m

$$L = \left(\frac{200 * 139.89 * \pi}{180}\right) = 488.31\text{m}$$

$L_{measured}$ = 488.32 m

$$e = 200 * \sec\left(\frac{139.89}{2}\right) - 200 = 383.22\,\text{m}$$

$e_{measured}$ = 383.26 m

4. Calculation of Stations' Kilometers

Kilometers of critical stations on the route should be given as the following table.

Station	Km
A	0+000
SS	$0+373^{67}$
PVC	$0+385^{52}$
PC	$0+403^{67}$
SM_1	$0+418^{67}$
B	$0+647^{83}$
BVC	$0+756^{02}$
SM_2	$0+876^{99}$
PT	$0+891^{99}$
SE	$0+921^{99}$
PVT	$1+126^{52}$
C	$1+160^{19}$

5. Ground Elevations used on the plan and profile

Ground elevations of all stations on the plan should be given as the following.

Station	Km	Ground Elevation (m)
A	0+000	625.00
1	$0+048^{27}$	630.00
H_1	0+100	630.70
2	$0+125^{79}$	630.00
H_2	0+200	626.92
3	$0+247^{80}$	630.00
4	$0+278^{22}$	635.00
5	$0+299^{52}$	640.00
6	$0+317^{36}$	645.00
7	$0+340^{04}$	650.00
8	$0+366^{18}$	655.00
SS	$0+373^{67}$	655.86
PVC	$0+385^{52}$	657.21
PC	$0+403^{67}$	659.28
9	$0+408^{08}$	660.00

SM_1	$0+418^{67}$	661.21
10	$0+451^{77}$	665.00
11	$0+488^{02}$	670.00
H_5	0+500	671.15
12	$0+568^{44}$	670.00
13	$0+589^{61}$	665.00
H_6	0+600	663.56
14	$0+628^{18}$	660.00
B	$0+647^{83}$	659.44
15	$0+700^{48}$	655.00
16	$0+734^{62}$	650.00
BVC	$0+756^{02}$	649.70
H_8	0+800	649.06
17	$0+846^{69}$	650.00
SM_2	$0+876^{99}$	654.24
18	$0+882^{38}$	655.00
PT	$0+891^{99}$	656.96
19	$0+906^{38}$	660.00
20	$0+918^{05}$	665.00
SE	$0+921^{99}$	666.15
21	$0+935^{18}$	670.00
22	$0+957^{43}$	675.00
23	$0+983^{46}$	680.00
H_{10}	1+000	682.70
24	$1+019^{54}$	685.00
25	$1+045^{94}$	685.00
26	$1+087^{07}$	680.00
H_{11}	1+100	678.80
PVT	$1+126^{52}$	677.13
C	$1+160^{19}$	675.00

6. Calculations of Vertical Curves

All calculations of vertical curves should be written in detail on this section. After that, calculations of all stations' elevation on the vertical curve should be given using the following table.

Kilometer and elevation of PVI, and slopes of grade lines are read from drawing as following:

$PVI_{km} = 0+756^{02}$

PVIelv = 667.86m

$g_1 = 5.67\%$

$g_2 = 1.77\%$

The minimum vertical curve radius, R is 5000 m, however, it is selected as 19000 m to prevent designing a vertical curve with small radius in horizontal curve, to obtain safer and more comfortable road.

$G = g_1 – g_2 = (5.67 – 1.77)\% = 3.90\%$

$L = G \times R = 0.039 \times 19000 = 741$ m

$t = L/2 = 370.5$ m

$e = G \times L /8 = 0.039 \times 741 / 8 = 3.61$ m

$PVC_{km} = PVI_{km} – t = 756.02 – 370.5 = 0+385^{52}$

$PVT_{km} = PVI_{km} + t = 756.02 + 370.5 = 0+1126^{52}$

$BVC_{km} = PVI_{km} = 0+756^{02}$

$PVC_{elv} = PVI_{elv} – t*g_1 = 667.86 – 370.5 \times 0.0567 = 646.85$ m

$PVT_{elv} = PVI_{elv} + t*g_2 = 667.86 + 370.5 \times 0.0177 = 674.42$ m

$BVC_{elv} = PVI_{elv} – e = 667.86 – 3.61 = 664.25$m

Station	**Km**	**x (m)**	**$r = g_1 \times x$**	**$PVC_{elv} + r$**	**$y = k \times x^2$**	**$PVC_{elv} + r - y$**
PVC	$0+385^{52}$	0	0.0000	646.8527	0.0000	646.85
PC	$0+403^{67}$	18.15	1.0291	647.8818	0.0087	647.87
SM_1	$0+418^{67}$	33,15	1,8796	648,7323	0,0289	648,70
9	$0+408^{08}$	22.56	1.2792	648.1318	0.0134	648.12
10	$0+451^{77}$	66.25	3.7564	650.6090	0.1155	650.49
11	$0+488^{02}$	102.5	5.8118	652.6644	0.2765	652.39
H_5	0+500	114.48	6.4910	653.3437	0.3449	653.00
12	$0+568^{44}$	182.92	10.3716	657.2242	0.8805	656.34
13	$0+589^{61}$	204.09	11.5719	658.4246	1.0961	657.33
H_6	0+600	214.48	12.1610	659.0137	1.2106	657.80
14	$0+628^{18}$	242.66	13.7588	660.6115	1.5496	659.06
B	$0+647^{83}$	262.31	14.8730	661.7256	1.8107	659.91
15	$0+700^{48}$	314.96	17.8582	664.7109	2.6105	662.10
16	$0+734^{62}$	349.1	19.7940	666.6466	3.2071	663.44
BVC	$0+756^{02}$	370.5	21.0074	667.8600	3.6124	664.25
H_8	$0+800^{00}$	414.48	23.5010	670.3537	4.5209	665.83
17	$0+846^{69}$	461.17	26.1483	673.0010	5.5968	667.40
SM_2	$0+876^{99}$	491,47	27,8663	674,7190	6,3564	668,36

18	$0+882^{38}$	496.86	28.1720	675.0246	6.4966	668.53
PT	$0+891^{99}$	506.47	28.7168	675.5695	6.7503	668.82
19	$0+906^{38}$	520.86	29.5328	676.3854	7.1393	669.25
20	$0+918^{05}$	532.53	30.1945	677.0471	7.4628	669.58
SE	$0+921^{99}$	536,47	30,4178	677,2705	7,5737	669,70
21	$0+935^{18}$	549.66	31.1657	678.0184	7.9507	670.07
22	$0+957^{43}$	571.91	32.4273	679.2799	8.6074	670.67
23	$0+983^{46}$	597.94	33.9032	680.7558	9.4087	671.35
H_{10}	1+000	614.48	34.8410	681.6937	9.9365	671.76
24	$1+019^{54}$	634.02	35.9489	682.8016	10.5785	672.22
25	$1+045^{94}$	660.42	37.4458	684.2985	11.4778	672.82
26	$1+087^{07}$	701.55	39.7779	686.6305	12.9519	673.68
H_{11}	1+100	714.48	40.5110	687.3637	13.4337	673.93
PVT	$1+126^{52}$	741	42.0147	688.8674	14.4495	674.42

7. Calculation of Grade Elevations on The Profile

Calculations of grade lines and grade elevations should be given in detail. After calculation of the grade elevations of all stations line on the profile, the following table should be prepared.

Station	Km	Ground Elevation (m)	Grade Elevation (m)	Height of Cut (m)	Height of Fill (m)
A	0+000	625.00	625.00		
1	$0+048^{27}$	630.00	627.74	2.26	
H_1	0+100	630.70	630.67	0.03	
2	$0+125^{79}$	630.00	623.13	6.87	
H_2	0+200	626.92	636.34		9.42
3	$0+247^{80}$	630.00	639.05		9.05
4	$0+278^{22}$	635.00	640.77		5.77
5	$0+299^{52}$	640.00	641.98		1.98
6	$0+317^{36}$	645.00	642.99	2.01	
7	$0+340^{04}$	650.00	644.27	5.73	
8	$0+366^{18}$	655.00	645.76	9.24	
SS	$0+373^{67}$	655.86	646.19	9.67	
PVC	$0+385^{52}$	657.21	646.85	10.36	
PC	$0+403^{67}$	659.28	647.87	11.41	
9	$0+408^{08}$	660.00	648.12	11.88	
SM_1	$0+418^{67}$	661.21	648.70	12.51	
10	$0+451^{77}$	665.00	650.49	14.51	
11	$0+488^{02}$	670.00	652.39	17.61	
H_5	0+500	671.15	653.00	18.15	
12	$0+568^{44}$	670.00	656.34	13.66	
13	$0+589^{61}$	665.00	657.33	7.67	
H_6	0+600	663.56	657.80	5.76	
14	$0+628^{18}$	660.00	659.06	0.94	
B	$0+647^{83}$	659.44	659.91		0.47
15	$0+700^{48}$	655.00	662.10		7.1

16	$0+734^{62}$	650.00	663.44		13.44
BVC	$0+756^{02}$	649.70	664.25		14.55
H_8	0+800	649.06	665.83		16.77
17	$0+846^{69}$	650.00	667.40		17.4
SM_2	$0+876^{99}$	654.24	668.36		14.12
18	$0+882^{38}$	655.00	668.53		13.53
PT	$0+891^{99}$	656.96	668.82		11.86
19	$0+906^{38}$	660.00	669.25		9.25
20	$0+918^{05}$	665.00	669.58		4.58
SE	$0+921^{99}$	666.15	669.70		3.55
21	$0+935^{18}$	670.00	670.07		0.07
22	$0+957^{43}$	675.00	670.67	4.33	
23	$0+983^{46}$	680.00	671.35	8.65	
H_{10}	1+000	682.70	671.76	10.94	
24	$1+019^{54}$	685.00	672.22	12.78	
25	$1+045^{94}$	685.00	672.82	12.18	
26	$1+087^{07}$	680.00	673.68	6.32	
H_{11}	1+100	678.80	673.93	4.87	
PVT	$1+126^{52}$	677.13	674.41	2.72	
C	$1+160^{19}$	675.00	675.00		

8. Calculations of Horizontal Curves and Super-Elevations

All calculations of horizontal curves on the route should be written in detail. These calculations should include: control of super-elevation, determination of Restricted Speed if there is a restricted speed, determination of Length of Super-Elevation without transition curve, and calculations of stations' kilometers related to Super-Elevation application (SS, SM_1, SM_2, SE). For application of super-elevation, all calculations should be given using the following table. These calculations should include: calculations of super-elevation and height of super-elevations of all stations on the Length of Super-Elevation application.

Minimum horizontal curve radius for 3rd class highway is 200 m and the curve radius is selected as 200 m, therefore speed restriction is not necessary.

$$\text{Super-elevation} = 0.00443 \times \frac{V_d^{\,2}}{R} = 0.00443 \times \frac{60^2}{200} = 0.08 = 8\%$$

$d_{max} = 8\%$

$d_{min} = 2\%$

Raccordement length,

$$L_R = 0.0354 \times \frac{V_d^3}{R} = 0.0354 \times \frac{60^3}{200} = 38.23\text{m}$$

$L_{R,min} = 45\text{m} > L_R = 38.23\text{m}$

So,

$L_R = 45$ m

Km of super-elevation application starting station,

$$SS_{km} = PC_{km} - \frac{2}{3}L_R = 403.67 - \frac{2}{3}\times 45 = 373.67\text{m} = 0{+}373^{67}$$

Km of max. super-elevation starting station in curve,

$$SM_{1,km} = PC_{km} + \frac{1}{3}L_R = 403.67 + \frac{1}{3}\times 45 = 418.67\text{m} = 0{+}418^{67}$$

Km of max. super-elevation ending station in curve,

$$SM_{2,km} = PT_{km} - \frac{1}{3}L_R = 891.99 - \frac{1}{3}\times 45 = 876.99\text{m} = 0{+}876^{99}$$

Km of super-elevation application ending station,

$$SE_{km} = PT_{km} + \frac{2}{3}L_R = 891.99 + \frac{2}{3}\times 45 = 921.99\text{m} = 0{+}921^{99}$$

Curve No: 1		**Inside Edge (Left)**			**Outside Edge (Right)**		
Station	**km**	**q (%)**	**h (m)**	**Grade Elevation (m)**	**q (%)**	**h (m)**	**Grade Elevation (m)**
SS	$0{+}373^{67}$	-2,00	-0,080	646,11	-2,00	-0,080	646,11
PVC	$0{+}385^{52}$	-2,00	-0,080	646,77	0,63	0,025	646,88
PC	$0{+}403^{67}$	4,67	0,187	648,06	4,67	0,187	648,06
9	$0{+}408^{08}$	5,65	0,226	648,35	5,65	0,226	648,35
SM_1	$0{+}418^{67}$	-8,00	-0,320	648,38	8,00	0,320	649,02
10	$0{+}451^{77}$	-8,00	-0,320	650,17	8,00	0,320	650,81
11	$0{+}488^{02}$	-8,00	-0,320	652,07	8,00	0,320	652,71
H5	$0{+}500^{00}$	-8,00	-0,320	652,68	8,00	0,320	653,32
12	$0{+}568^{44}$	-8,00	-0,320	656,02	8,00	0,320	656,66
13	$0{+}589^{61}$	-8,00	-0,320	657,01	8,00	0,320	657,65
H6	$0{+}600^{00}$	-8,00	-0,320	657,48	8,00	0,320	658,12
14	$0{+}628^{18}$	-8,00	-0,320	658,74	8,00	0,320	659,38
B	$0{+}647^{83}$	-8,00	-0,320	659,59	8,00	0,320	660,23
15	$0{+}700^{48}$	-8,00	-0,320	661,78	8,00	0,320	662,42
16	$0{+}734^{62}$	-8,00	-0,320	663,12	8,00	0,320	663,76
BVC	$0{+}756^{02}$	-8,00	-0,320	663,93	8,00	0,320	664,57
H8	0+800	-8,00	-0,320	665,51	8,00	0,320	666,15
17	$0{+}846^{69}$	-8,00	-0,320	667,08	8,00	0,320	667,72
SM_2	$0{+}876^{99}$	-8,00	-0,320	668,04	8,00	0,320	668,68
18	$0{+}882^{38}$	6,80	0,272	668,80	6,80	0,272	668,80
PT	$0{+}891^{99}$	4,67	0,187	669,01	4,67	0,187	669,01
19	$0{+}906^{38}$	-2,00	-0,080	669,17	1,47	0,059	669,31
20	$0{+}918^{05}$	-2,00	-0,080	669,50	-1,12	-0,045	669,54
SE	$0{+}921^{99}$	-2,00	-0,080	669,62	-2,00	-0,080	669,62