NATIONAL HIGHWAY HYDERABAD TO VIJAYAWADA GEOMETRIC ROAD DESIGNING

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ABSTRACT
Highway design and explains how they interact to create a basis for the preliminary route selection and design. Projects are followed from the initial provision of a topographic map and specifications through to the investment and user cost estimates of a particular highway. Vertical and horizontal alignment, drainage issues, and potential environmental impacts. Economic cost analysis and its applications, include an outline of route selection and design methods aided by digital terrain and computerized alignment modeling. Geometric design is an important phase in the highway design process that is directly related to traffic safety. Highway elements should be jointly designed to account for such design criteria as sight distance, vehicle stability, driver comfort, drainage, and aesthetics. Intuitively, such a design should be based on a three-dimensional (3-D) analysis. The National Highway geometric design is carried out on the assumption of design speed, which implies the notation of a "design driver". Highway Traffic Safety Administration staff evaluated the actual costs, benefits and crash performance of current energy-absorbing steering assemblies as part of its review of existing major regulations. The evaluation was based on statistical analyses of Fatal Accident Reporting System, National Crash Severity Study and Multidisciplinary Accident Investigation data, cost analyses of production steering assemblies and review of test results. Energy-absorbing steering assemblies have significantly reduced deaths and serious injuries and they are cost-effective. Nevertheless, many seriousinjuries to the thorax and other body regions still occur with the current systems.

KEY WORDS: *Highway geometric design, three-dimensional analysis, sight distance, vehicle dynamics, drainage, highway aesthetics, operating speed, drivers' perception and behavior*

Introduction
The National Highway No. 9 (New NH No.65) starts from the intersection points of NH-9 & NH-7 at Hyderabad in the State of Andhra Pradesh and after traversing through Choutuppal, Chityala, Narketpally, Nakrekal, Suryapet, Sholapur, Vijayawada and terminates at Machhlipatnam (Seaport). The Project road starts from km 40.000 at Malkapuram from the outskirts of Hyderabad, the capital city of Andhra Pradesh State and terminates at km 221.500 Totacherla. The project road (NH 9)(New NH No.65) "Starts" from Malkapuram Village at km 40.000 and "Ends" Totacherla village at km 221.500. Project includes developing the existing two lane carriageway to four lane dual carriageway configurations including strengthening of existing two lane between km 40.000 to km 221.500 on BOT basis and defined as "Project Highway".

1.1 Description of project highway
The existing project road is a 2-lane carriageway with average width of 7.0m and 1.00 m average width of earthen / hard shoulders on either side on Hyderabad – Vijayawada Section including Suryapet bypass. The existing pavement is flexible type. The average height of embankment is 1.0m (varies from 0.0 to 5.0m) except on the approaches to bridges where height of embankment varies from 7m to 8m. The existing Right of way (ROW) for the Project Highway is varies from 17.85m to 30.0m except for bypasses. The land has to be acquired for the proposed widening along the alignment for a total width of 60m ROW.

An Index Map and location plan of the Project Highway is given in **Figure 1.1a** and **1.1b**.

Figure 1.1a: Index Map of the Project Highway

Figure 1.1b: Index Map of the Project Highway

Referencing System

The kilometer stones (km – stones) existing all along with entire length of the Project Highway is referred to as "Existing Chainage". **Table 1.1** gives relationship between the "Existing Chainage" i.e. km – stone and the "Design Chainage" as per the field surveys using total station for the Project Highway.

Table 1.1 Design Chainage Corresponding to Existing Kilometer Stone from km 40.00 to km 160.00

Sl. No	Existing Chainage (km)	Design Chainage (km)		Sl. No	Existing Chainage (km)	Design Chainage (km)
1	40	40		271	98	97.821
2	40.2	40.144		272	98.2	98.02
3	40.4	40.397		273	98.4	98.22
4	40.6	40.596		274	98.6	98.418
5	40.8	40.799		275	98.8	98.621
6	41	40.995		276	99	98.819
7	41.2	41.183		277	99.2	99.022
8	41.4	41.38		278	99.6	99.417
9	41.6	41.588		279	99.8	99.617
10	41.8	41.79		280	100	99.828
11	42	41.99		281	100.2	100.026
12	42.2	42.187		282	100.4	100.228
13	42.4	42.38		283	100.6	100.428
14	42.6	42.583		284	100.8	100.628
15	42.8	42.795		285	101	100.822
16	43	42.977		286	101.2	101.026
17	43.2	43.179		287	101.4	101.226
18	43.4	43.395		288	101.6	101.424
19	43.6	43.575		289	101.8	101.624
20	43.8	43.786		290	102	101.824
21	44	43.974		291	102.2	102.023
22	44.2	44.174		292	102.4	102.221
23	44.4	44.374		293	102.6	102.423
24	44.6	44.582		294	102.8	102.623
25	44.8	44.772		295	103	102.828
26	45	44.973		296	103.2	103.009
27	45.2	45.173		297	103.4	103.209
28	45.4	45.372		298	103.6	103.408
29	45.6	45.572		299	103.8	103.609
30	45.8	45.772		300	104	103.808
31	46	45.971		301	104.2	104.008
32	46.2	46.172		302	104.4	104.208
33	46.4	46.472		303	104.6	104.406
34	46.6	46.572		304	104.8	104.608
35	46.8	46.772		305	105	104.809
36	47	46.97		306	105.2	105.007
37	47.2	47.167		307	105.4	105.205
38	47.4	47.368		308	105.6	105.41
39	47.6	47.564		309	105.8	105.601
40	47.8	47.764		310	106	105.803
41	48	47.963		311	106.2	106.003
42	48.2	48.165		312	106.4	106.202
43	48.4	48.364		313	106.6	106.402
44	48.6	48.571		314	106.8	106.602
45	48.8	48.767		315	107	106.802
46	49	48.967		316	107.2	107.002

Sl. No	Existing Chainage (km)	Design Chainage (km)		Sl. No	Existing Chainage (km)	Design Chainage (km)
47	49.2	49.163		317	107.4	107.205
48	49.4	49.363		318	107.6	107.402
49	49.6	49.563		319	107.8	107.601
50	49.8	49.761		320	108	107.802
51	50	49.962		321	108.2	108
52	50.2	50.163		322	108.4	108.199
53	50.4	50.362		323	108.6	108.399
54	50.6	50.559		324	108.8	108.599
55	50.8	50.757		325	109	108.798
56	51	50.956		326	109.2	108.998
57	51.2	51.156		327	109.4	109.196
58	51.4	51.355		328	109.6	109.395
59	51.6	51.559		329	109.8	109.595
60	51.8	51.759		330	110	109.795
61	52.2	52.118		331	110.2	109.994
62	52.6	52.56		332	110.4	110.195
63	52.8	52.758		333	110.506	110.3 (Start of Nakrekallu Bypass)
64	53	52.958		334	115.592	115.45 (End of Nakrekallu Bypass)
65	53.2	53.158		335	115.6	115.458
66	53.4	53.357		336	115.8	115.655
67	53.6	53.558		337	116	115.825
68	53.8	53.758		338	116.2	116.04
69	54	53.956		339	116.4	116.247
70	54.2	54.155		**Design Chainage : km 116.430 will henceforth be called as km 116.150**		
71	54.4	54.345		340	116.6	116.166
72	54.6	54.555		341	116.8	116.365
73	54.8	54.754		342	117	116.564
74	55	54.955		343	117.2	116.763
75	55.2	55.155		344	117.4	116.961
76	55.4	55.354		345	117.6	117.161
77	55.6	55.554		346	117.8	117.361
78	55.8	55.753		347	118	117.561
79	56	55.953		348	118.2	117.761
80	56.2	56.152		349	118.4	117.959
81	56.4	56.351		350	118.6	118.159
82	56.6	56.551		351	118.8	118.359
83	56.8	56.751		352	119	118.558
84	57	56.95		353	119.2	118.757

Sl. No	Existing Chainage (km)	Design Chainage (km)		Sl. No	Existing Chainage (km)	Design Chainage (km)
85	57.2	57.149		354	119.4	118.962
86	57.4	57.347		355	119.6	119.155
87	57.6	57.548		356	119.8	119.355
88	57.8	57.748		357	120	119.755
89	58	57.945		358	120.2	119.956
90	58.2	58.145		359	120.4	120.155
91	58.4	58.342		360	120.6	120.356
92	58.6	58.545		361	120.8	120.553
93	58.8	58.742		362	121	120.75
94	59	58.942		363	121.2	120.953
95	59.2	59.146		364	121.4	121.15
96	59.4	59.345		365	121.6	121.351
97	59.6	59.541		366	121.8	121.55
98	59.8	59.741		367	122	121.754
99	60	59.956		368	122.2	121.953
100	60.2	60.157		369	122.4	122.145
101	60.4	60.341		370	122.6	122.345
102	60.6	60.537		371	122.8	122.545
103	60.8	60.74		372	123	122.749
104	61	60.94		373	123.2	122.948
105	61.2	61.139		374	123.4	123.15
106	61.4	61.34		375	123.6	123.352
107	61.6	61.54		376	123.8	123.547
108	61.8	61.739		377	124	123.749
109	62	61.942		378	124.2	123.919
110	62.2	62.138		379	124.4	124.103
111	62.4	62.338		380	124.6	124.306
112	62.6	62.536		381	124.8	124.506
113	62.8	62.738		382	124.9	124.6 (Musi Realignment starts)
114	63	62.939		383	128.2	128.005 (Musi Realignment ends)
115	63.2	63.116		384	128.4	128.205
116	63.4	63.325		**Design Chainage : km 128.342 will henceforth be called as km 128.500**		
117	63.6	63.514		385	128.6	128.565
118	63.8	63.713		386	128.8	128.753
119	64	63.913		387	129	128.97
120	64.2	64.112		388	129.2	129.14
121	64.4	64.315		389	129.4	129.334

Sl. No	Existing Chainage (km)	Design Chainage (km)		Sl. No	Existing Chainage (km)	Design Chainage (km)
122	64.6	64.513		390	129.6	129.534
123	64.8	64.709		391	129.8	129.734
124	65	64.909		392	130	129.931
125	65.2	65.115		393	130.2	130.128
126	65.4	65.308		394	130.4	130.328
127	65.6	65.498		395	130.6	130.527
128	65.8	65.706		396	130.8	130.726
129	66	65.907		397	131	130.926
130	66.2	66.103		398	131.2	131.128
131	66.4	66.307		399	131.4	131.327
132	66.6	66.507		400	131.6	131.526
133	66.8	66.706		401	131.8	131.73
134	67	66.905		402	132	131.926
135	67.2	67.106		403	132.2	132.125
136	67.4	67.302		404	132.4	132.327
137	67.6	67.503		405	132.6	132.525
138	67.8	67.704		406	132.8	132.725
139	68	67.903		407	133	132.925
140	68.2	68.104		408	133.2	133.127
141	68.4	68.303		409	133.4	133.321
142	68.6	68.503		410	133.6	133.51
143	68.8	68.702		411	133.8	133.705
144	69	68.9		412	134	133.908
145	69.2	69.089		413	134.2	134.106
146	69.4	69.299		414	134.4	134.303
147	69.6	69.499		415	134.6	134.5
148	69.8	69.702		416	134.8	134.703
149	70	69.898		417	135	134.906
150	70.2	70.099		418	135.2	135.098
151	70.4	70.299		419	135.4	135.29
152	70.6	70.498		420	135.6	135.481
153	70.8	70.697		421	135.8	135.678
154	71	70.9		422	136	135.876
155	71.2	71.097		423	136.2	136.078
156	71.4	71.296		424	136.4	136.263
157	71.6	71.497		425	136.6	136.449
158	71.8	71.696		426	136.8	136.734
159	72	71.894		427	137	136.87
160	72.2	72.095		428	137.2	137.07
161	72.4	72.294		429	137.4	137.269
162	72.6	72.495		430	137.6	137.475
163	72.8	72.695		431	137.8	137.665

Sl. No	Existing Chainage (km)	Design Chainage (km)		Sl. No	Existing Chainage (km)	Design Chainage (km)
164	73	72.894		432	138	137.861
165	73.2	73.094		433	138.2	138.063
166	73.4	73.294		434	138.4	138.262
167	73.6	73.493		435	138.6	138.46
168	73.8	73.692		436	138.8	138.659
169	74	73.892		437	139	138.856
170	74.2	74.09		438	139.2	139.033
171	74.4	74.29		439	139.4	139.196
172	74.6	74.491		440	139.6	139.437
173	74.8	74.691		441	139.8	139.633
174	75	74.89		442	140	139.831
175	75.2	75.089		443	140.2	140.034
176	75.4	75.289		444	140.4	140.232
177	75.6	75.489		445	140.6	140.446
178	75.8	75.689		446	140.8	140.63
179	76	75.889		447	141	140.829
180	76.2	76.089		448	141.2	141.031
181	76.4	76.288		449	141.4	141.23
182	76.6	76.488		450	141.6	141.426
183	76.8	76.689		451	141.8	141.625
184	77	76.887		452	142	141.824
185	77.2	77.089		**Design Chainage : km 142.108 will henceforth be called as km 142.100**		
				453	142.2	142.023
186	77.4	77.287		454	142.4	142.223
187	77.6	77.488		455	142.6	142.423
188	77.8	77.687		456	142.8	142.623
189	78	77.885		457	143	142.827
190	78.2	78.082		458	143.2	143.01
191	78.4	78.282		459	143.4	143.21
192	78.6	78.478		460	143.6	143.406
193	78.8	78.685		461	143.8	143.605
194	79	78.882		462	144	143.805
195	79.2	79.079		463	144.2	144.004
196	79.4	79.282		464	144.4	144.204
197	79.6	79.475		465	144.6	144.403
198	79.8	79.689		466	144.8	144.602
199	80	79.873		467	145	144.802
200	80.2	80.077		468	145.2	145.001
201	80.4	80.278		469	145.4	145.201
202	80.6	80.475		470	145.6	145.4

Sl. No	Existing Chainage (km)	Design Chainage (km)		Sl. No	Existing Chainage (km)	Design Chainage (km)
203	80.8	80.676		471	145.8	145.573
204	81	80.882		472	146	145.801
205	81.2	81.077		473	146.2	146.003
206	81.4	81.277		474	146.4	146.193
207	81.6	81.477		475	146.6	146.395
208	81.8	81.677		476	146.8	146.599
209	82	81.875		477	147	146.793
210	82.2	82.074		478	147.2	146.993
211	82.4	82.275		479	147.4	147.191
212	82.6	82.474		480	147.6	147.391
213	82.8	82.675		481	147.8	147.543
214	83	82.874		482	148	147.785
215	83.2	83.071		483	148.2	147.987
216	83.4	83.271		484	148.4	148.185
217	83.6	83.467		485	148.6	148.385
218	83.8	83.667		486	148.8	148.584
219	84	83.869		487	149	148.783
220	84.2	84.066		488	149.2	148.981
221	84.4	84.268		489	149.4	149.186
222	84.6	84.469		490	149.6	149.38
223	84.8	84.677		491	149.8	149.58
224	85	84.86		492	150	149.782
225	85.2	85.06		493	151	150.767
226	85.338	85.2 (Start of Narketpally Bypass)		494	151.2	150.966
227	88.826	89.2 (End of Narketpally Bypass)		495	151.4	151.165
228	89	89.369		496	151.6	151.364
229	89.2	89.571		497	151.8	151.562
Design Chainage : km 89.732 will henceforth be called as km 89.200				498	152	151.762
230	89.4	89.24		499	152.2	151.961
231	89.6	89.437		500	152.4	152.161
232	89.8	89.611		501	152.6	152.358
233	90	89.81		502	152.8	152.559
234	90.2	90.011		503	153	152.76
235	90.4	90.235		504	153.2	152.957
236	90.6	90.436		505	153.4	153.157
237	90.8	90.636		506	153.6	153.356

Sl. No	Existing Chainage (km)	Design Chainage (km)		Sl. No	Existing Chainage (km)	Design Chainage (km)
238	91	90.834		507	153.8	153.554
239	91.2	91.034		508	154	153.751
240	91.4	91.233		509	154.2	153.95
241	91.6	91.433		510	154.4	154.15
242	91.8	91.665		511	154.6	154.348
243	92	91.831		512	154.8	154.548
244	92.2	92.033		513	155	154.748
245	92.4	92.234		514	155.2	154.952
246	92.6	92.434		515	155.4	155.144
247	92.8	92.634		516	155.6	155.338
248	93	92.833		517	155.8	155.541
249	93.4	93.234		518	156	155.739
250	93.6	93.432		519	156.2	155.938
251	93.8	93.632		520	156.4	156.138
252	94	93.831		521	156.6	156.336
253	94.2	94.03		522	156.8	156.536
254	94.4	94.23		523	157	156.734
255	94.6	94.429		524	157.2	156.934
256	94.8	94.629		525	157.4	157.132
257	95	94.828		526	157.6	157.332
258	95.2	95.027		527	157.8	157.531
259	95.4	95.227		528	158	157.726
260	95.6	95.426		529	158.2	157.925
261	95.8	95.627		530	158.4	158.121
262	96	95.826		531	158.6	158.308
263	96.2	96.026		532	158.8	158.507
264	96.4	96.246		533	159	158.705
265	96.6	96.414		534	159.2	158.903
266	96.8	96.624		535	159.4	159.102
267	97.2	97.042		536	159.6	159.303
268	97.4	97.223		537	159.8	159.505
269	97.6	97.423		538	160	159.706
270	97.8	97.622				

PAVEMENT DESIGN

Pavement design is a very critical component for the urban arterial highway and the requirements will be analyzed in depth taking into account relevant design parameters such as traffic projection, design cumulative ESA, materials characteristics and the climatic conditions.

The cumulative ESA (Equivalent Standard Axle) will be made available from the traffic forecast model. An appropriate fixed value for the ultimate design life and the progression of ESA values for phased construction for different vehicle

Volume Count Location	Km-50.00	Km-110.00	Km-130.00	Km-152.00
Two-Wheeler	2654	718	1237	582
Three-Wheeler	1095	609	1086	529
Car/Jeep	3407	1607	1797	908
Mini-Bus	50	38	71	30
Bus	1751	1075	1197	574
LCV	878	138	454	106
2-Axle	3306	2562	2548	1538
3-Axle	1979	1328	1545	978
MAV	198	123	199	92
Tractor With Trailer	58	51	194	52
Tractor Without Trailer	56	24	91	21
Cycle	178	151	314	164
Cycle Rickshaw	5	2	20	3
Animal drawn vehicles	1	1	16	4
Horse Cart	1	0	0	0
Others	0	2	2	2
Total Non-Motorised Vehicles	**185**	**155**	**351**	**173**
Total Motorised Vehicles	**15434**	**8273**	**10420**	**5417**
Total Vehicles	**15618**	**8428**	**10772**	**5590**
Total PCU	**29845**	**18717**	**22677**	**12073**

categories will be established for the project road. Vehicle damage factor will be available from the axle load survey. As strengthening course, flexible pavement will be provided designed based on IRC: 81-1997. Strategy for the materials to be used in profile corrective course will be decided after ascertaining the required thickness and the due consideration will be given to economize the item without compromising on the needed strength.

Both rigid and flexible pavement options will be exercised in case of additional two-lanes. Life cycle cost analysis will be carried out in order to decide the most viable option. Flexible pavement will be designed not merely on the method given in IRC: 37-2012 but the layer equivalency theory given in AASHTO will also be applied along with the serviceability factor in order to optimize the crust design. Rigid pavement will be designed as per the provisions contained in IRC: 58-2012. However, dowel and tie bars will be designed based on the AASHTO considerations.

Besides the above, designs for service roads, toll plaza, parking bays and cross roads will be carried out. Pavement management system will be evolved. Maintenance needs (during construction and post- construction) and the future renewal courses will be defined. A strategy will be formulated to suggest utilization of abandoned road stretches.

Average Daily Traffic

Survey Location		Hyderabad – Vijayawada	
		At km 163	At km 216
Car		1082	1512
Auto Rick		840	1198
Two wheelers		1070	1218
Mini Bus			40
Bus		786	1138
LCV		308	126
2-Axle Truck		823	1265
3-Axle Truck		874	1133
MAV		82	100
Agr. Tractor		52	45
Agr. tractor with trailer		91	35
Total Toll able Vehicles		**3990**	**5311**
Slow Moving and Toll Exempted Vehicles			
Cycle		648	543
Cycle Rick		33	43
Animal / Hand Cart		6	4
Other Toll exempted vehicles	Car	9	10
	LCV	1	4
	Truck	1	1
	Bus	1	1
Total Motorised Vehicles		**6065**	**7836**
Total Non motorised Vehicles		**687**	**590**
Total Vehicles		**6752**	**8426**
Total Motorised PCU		**11301**	**14883**
Total Non Motorised PCU		**426**	**382**
Total PCU		**11727**	**15265**

Proposed Traffic Surveys

The survey formats will be designed as per the guidelines suggested in

IRC: SP: 19-2001"Manual for Survey, Investigation and Preparation of Road Projects", and used in consultation with NHAI. The data collected from the primary field surveys will be thoroughly analysed to arrive at the desired results for the study. However, each traffic survey will have its own significance and interpretation as discussed below.

Classified traffic volume count survey

The Consultant will carry out 7-day continuous classified traffic volume count at the identified traffic count stations on each traffic homogeneous section of the project roads and at selected locations on regional roads. Traffic volume count will be conducted at mid-block locations where the present traffic is expected to be representative of the homogeneous section traffic. The location of traffic counts will be finalised in consultation with NHAI and the data will be recorded on the prescribed survey formats. The field data will be analysed to obtain the Average Daily Traffic (ADT), average hourly variation of traffic, vehicular composition for each traffic count location and estimation of Annual Average Daily Traffic (AADT) on the project road with proper seasonal correction.

Sample Size Collected during O-D Survey

	Hyderabad- Vijayawada Section	
Vehicle Type	**Munagala (km 163) Sample Size (%)**	**Near Navabpet (km 216) Sample Size (%)**
LCV	20.9	57.7
2 Axle Truck	30.2	35.1
3 Axle Truck	43.2	35.9
MAV	23.2	31.0
Car	43.1	32.5
Mini Bus	27.3	32.5
Private Bus	8.8	20.6
STU Bus	40.9	42.6

Sl. No.	Type of Survey	Survey Durations
1	Classified Traffic Volume Count	Continuous 7-day
2	Origin-Destination and commodity movement survey	For a continuous 24 hours on normal working day(s)
3	Axle Loading Characteristics Survey	For a continuous 24 hours on normal working day(s)
4	Intersection Volume Count Survey	For peak periods on a normal working day
5	Speed and Delay Survey	As necessary to complete six runs along project road
6	Pedestrian/Animal cross traffic count	As necessary to complete project road

Axle Load survey

Axle Load Survey was carried out at one location (km 163) on Hyderabad - Vijayawada section. The main purpose for carrying out the survey was to assess the overloading pattern on the corridor and to estimate Vehicle Damage Factor.

During the survey, Axle load of commercial vehicles, i.e. LCVs, 2-Axle, 3-Axle, Multi Axle Trucks and Buses, were weighed on random basis. The vehicles were stopped with the help of police and the drivers were directed to stop their vehicles in such a way that wheel of each axle can be weighed using portable Axle Load Weighing Pad. The readings were recorded by trained enumerators for each axle separately and the surveys were carried out for 48 Hours. A continuous traffic volume count survey will be carried out along with the axle load survey. The Axle load survey will be carried out on a random sampling basis for commercial vehicles (Freight Vehicles) along with few passenger buses to find out if they are overloaded. The Consultant intends to cover a minimum sample size of twenty (20) percent of freight vehicles plying on the project road. This survey will be carried out using two portable axle load pads, one for each direction on the project road. Since this survey involves stopping and guiding vehicles to axle load weigh locations, it is necessary to take help of local police to avoid traffic congestion and ensure safety during the survey period. Vehicle Damage Factor (VDF) will be

computed using IRC guidelines for further estimation of design traffic loadings during the project design period. Axle load surveys help in ascertaining the loading spectrum of the commercial vehicles plying on the road and in turn assessing the damage to the pavement caused by these vehicles. Therefore, information on axle loads in a road must be carefully gathered else the design traffic loadings for pavement design can be way off the mark. This risk becomes more serious if traffic from other roads is expected to be diverted to the project road in the future. The locations of the proposed axle load survey will be chosen to cover the spread of loadings in the influence area in an optimum manner.

- **Turning Movement survey**

The turning movement survey was conducted at eight major intersections falling on the project corridor to obtain information on directional movement of traffic at all major intersections along the project road. The survey was conducted for twelve hours from 8.00 am to 8.00 pm with the help of trained enumerators. Each turning movement at the intersection was recorded by deploying enumerators in sufficient numbers at suitable locations. The data on peak hourly directional movement would be used to analysis and design the intersection.

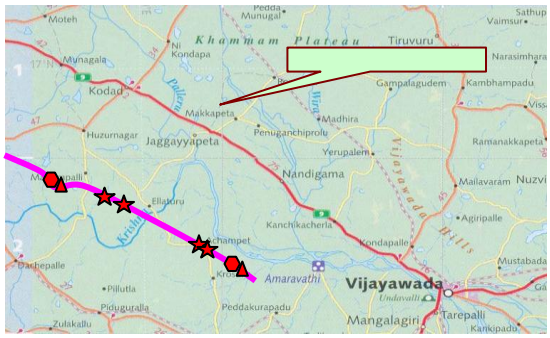
The turning movement counts will be conducted at junctions of the project road with NHs and SHs. Some of the junctions with ODR may also get qualified for survey based on influence zones. The survey data will be used to check various traffic management warrants including signalization and grade separation. It will also help in at-grade/grade separated intersection design and also provide additional data on connectivity of corridor sections. All the junctions considered for Turning Movement Count Survey are shown in the map given below.

Proposed Overlay Thickness

Chainage			Design Traffic	Design Deflection mm	BC, mm	DBM, mm	Proposed Composition and Thickness	
From	To	Length, km					BC, mm	DBM, mm
160	169	9	110	0.795	50	10	50	60
169	171	2	110	0.542	50	0	50	60
171	173	2	110	0.629	50	0	50	60
173	175	2	110	0.743	50	27	50	60
175	182	7	110	1.106	50	55	50	60
182	190	8	110	1.128	50	72	50	60
190	192	2	110	1.298	50	83	50	75
192	198	6	110	1.166	50	27	50	60
198	221.5	23.5	110	0.844	50	0	50	60

The designed thickness of rigid pavement for Toll Plazas, obtained from IRC 58 is presented

Sl No	Design Chainage (km)	Existing Structures Details		Proposed Structures Details		Remarks
		Total Width of Culverts (m)	Height from Road Top to Ground (m)	Span arrangements (No x Vent size) (m)	Opening Height (m)	
1	40.605	24.51	2.24	1 x 1.2 m Dia	1.20	Repair & Widening
2	40.750	25.81	1.89	1 x 1.2 m Dia	1.20	Repair & Widening
3	41.971	12.23	1.73	1 x 0.9m Dia	0.90	Repair & Widening
4	42.306	12.43	2.720	3 x 0.9m Dia	0.90	Repair & Widening
5	42.520	12.33	1.500	1 x 0.9m Dia	0.90	Repair & Widening
6	43.060	12.72	1.650	1 x 0.9m Dia	0.90	Repair & Widening
7	43.170	12.23	2.450	1 x 0.9m Dia	0.90	Repair & Widening
8	43.340	12.24	1.520	1 x 0.9m Dia	0.90	Repair & Widening
9	43.605	12.26	1.580	1 x 0.9m Dia	0.90	Repair & Widening
10	43.767	12.38	1.700	1 x 0.9m Dia	0.90	Repair & Widening
11	43.967	12.40	1.990	2 x 0.9m Dia	0.90	Repair & Widening
12	44.130	12.34	2.850	3 x 0.9m Dia	0.90	Repair & Widening
13	44.745	12.14	1.850	1 x 0.9m Dia	0.90	Repair & Widening
14	45.716	14.72	2.240	1 x 1.2m Dia	1.20	Repair & Widening
15	47.295	14.73	2.175	1 x 0.9m Dia	0.90	Repair & Widening
16	48.085	14.72	2.140	1 x 0.9m Dia	0.90	Repair & Widening
17	48.575	14.81	1.950	1 x 0.9m Dia	0.90	Repair & Widening
18	49.648	12.22	1.670	1 x 0.9m Dia	0.90	Repair & Widening
19	50.345	12.17	1.770	1 x 0.9m Dia	0.90	Repair & Widening
20	50.821	14.70	1.470	1 x 0.9m Dia	0.90	Repair & Widening
21	51.308	14.84	1.890	1 x 0.9m Dia	0.90	Repair & Widening
22	51.785	14.84	1.710	1 x 0.9m Dia	0.90	Repair & Widening
23	51.860	14.78	1.840	1 x 0.9m Dia	0.90	Repair & Widening
24	52.285	14.63	1.750	1 x 0.9m Dia	0.90	Repair & Widening
25	52.535	14.70		1 x 1.2m Dia	1.20	Reconstruction
26	54.021	17.32	1.430	1 x 0.9m Dia	0.90	Repair & Widening
27	60.843	14.33	1.790	1 x 0.9m Dia	0.90	Repair & Widening
28	61.668	11.80	1.850	1 x 0.9m Dia	0.90	Repair & Widening
29	62.191	12.34	1.850	4 x 0.9m Dia	0.90	Repair & Widening
30	62.231	14.69	2.130	1 x 0.9m Dia	0.90	Repair & Widening
31	63.575	14.69	1.690	1 x 0.9m Dia	0.90	Repair & Widening
32	64.725	14.52	1.690	1 x 0.9m Dia	0.90	Repair & Widening
33	66.015	12.31	1.390	1 x 0.9m Dia	0.90	Repair & Widening
34	66.580	12.36	1.670	1 x 0.9m Dia	0.90	Repair & Widening
35	67.085	14.60	1.930	1 x 0.9m Dia	0.90	Repair & Widening
36	67.545	14.68	1.870	2 x 0.9m Dia	0.90	Repair & Widening
37	67.860	14.60	1.620	1 x 0.9m Dia	0.90	Repair & Widening
38	68.425	14.55	1.950	2 x 0.9m Dia	0.90	Repair & Widening
39	69.583	13.72	1.890	2 x 0.9m Dia	0.90	Repair & Widening
40	70.107	14.59	1.700	1 x 0.9m Dia	0.90	Widening
41	70.775	14.57	1.765	1 x 0.9m Dia	0.90	Repair & Widening
42	70.998	14.43	1.930	1 x 0.9m Dia	0.90	Repair & Widening
43	71.355	13.44	1.870	2 x 0.9m Dia	0.90	Repair & Widening



Sharp Curve & No road markings Accident Zone @Suryapet

From km 160.000 to 221.500

There are 4 numbers of major and 11 minor junctions in Hyderabad – Vijayawada section. For improvement of major intersections underpass has been proposed. Minor intersections are proposed to be developed as per IRC standards. The approach roads are basically SH, MDR & ODR along the project road.

The lists of major / minor junctions are The table given below indicates the existing CD works with widening/new construction requirement. The recommendations need to be verified at site and detail designs developed for each case in consultation with independent consultant.

The details of each type of culvert, number of culverts repair and widen and new construction are given in **table**

Salient features of project road, From km 40.000 to km 160.000

- The project road starts from km. 40.000 near Malkapuram and ends at km. 160.00 near Syed Muzavarpet, covering a total length of 120 km. The road falls in Nalgonda district in the State of Andhra Pradesh.
- The land use pattern of the project area is mostly agricultural (59%), built up (27%) and barren (14%).
- Existing Row is 12m to 30m. Proposed Row is 60m throughout.
- 399.92 ha of land is being acquired; which includes 318.32 ha for widening, 81.6 ha for realignments.
- Two bypasses have been proposed at villages/towns namely Narketpally and Nakrekallu of length 4km and 5.15km respectively.
- There are 2 major bridges, 31 minor bridges, 75 box culverts and 145 pipe culverts in the project area.
- 27 vehicular/pedestrian/cattle underpasses, 27.05km of service roads have been provided at built up locations. Truck lay byes have been provided at 5 locations. 26 Bus bays and 18 bus shelters have been provided.
- The project road passes through 26 villages, which come under Nalgonda District

There are 5 congested areas where bypass / realignments have been proposed: -

- hityala: The project road has been realigned saving the Return wall of the existing RUB (km 77.200 to km 78.100)
- Narketpally: The alignment near the Khamenei Educational Society and an electrical substation has been

shifted to the LHS to save the same as they are of much importance (km 88.400 to km 90.300)

- Khetepally: A slight realignment has been done to save a church, which may result in religious disturbances (km 119.250 to km119.950)
- Musi Bridge (km123.4 to km128.340): The existing approaches of the bridge are of radius in the order of 250 m. So a new 6lane bridge at a distance of 140 m from the existing bridge on the RHS has been proposed. In the approach on the Vijayawada side the alignment has been realigned to save a village called Tekumatla.
- Nakrekallu: The existing alignment passes through the congested town of Nakrekallu. Hence a bypass on the RHS has been proposed.

From km 160.000 to km 221.500

The existing project road is two lane flexible pavements throughout its length including the bypasses. There are one major bridge, 14 minor bridges, one RUB at 203.850 and 114 culverts along the Project Highway. Out of 114 culverts, 64 nos. of RCC Slab, 43 Hume Pipe and remaining stone slab culverts widened by RCC slab were found. 9 nos. of vehicular underpasses, 6 nos. of cattle and 3 nos. of pedestrian underpasses have been proposed on the Project Highway section of NH-9 between km 160+000 to km 221+500. Service road has been proposed to be provided on all the habitat portions falling on this stretch. Number of the villages where service road has been provided total length of the service roads, on both sides of the highway, works out to16.00 kms length of 7 .0m and 5.50 m width.

ROAD SAFETY AUDIT REPORT

Road Safety Audit (RSA) is a formal procedure for assessing collision potential and safety performance in the provision of new roads and schemes for the improvement and maintenance of existing roads. However, its systematic application can also ensure that a growing awareness about good road safety principles is achieved throughout in highway planning, designing, construction and maintenance phases.

This Road Safety Audit aims to:

- Minimizing the likelihood of crashes.
- Ensuring that, if a crash occurs, the likelihood of the injury is minimized
- Ensuring that safety related design criteria have been met.

This report covers Safety Audit towards Design, Construction, Finance, Operation and Maintenance of 4/6 laning of Hyderabad Vijayawada Section of NH-65 (Old No.9) from Km.40.000 to Km.221.500.

Alignment and Road Safety

The horizontal alignment of the project road is straight in majority of the project road section with occasional sharp curves. Traffic signs are missing at many locations on the project road. Very few/No warning signs exist before the junction and curves. At minor/major junction's km stone are observed showing where the cross road leads to. Horizontal alignment is very poor in most of the sections and where crest curves exist with steep gradient, horizontal curves overlap with vertical curves resulting in poor visibility and making it very unsafe for the road users. The embankment height varies from 2.0 m to 3.0 m and the soft shoulder is poor at many locations with erosion/breaching of side slopes.

In general, the existing alignment of the project road runs mostly in straight alignment with more horizontal curves of easy curvature at few locations, which require geometric improvements for a design speed of 100 Kmph. The existing gradient of the project road is within acceptable standards as per IRC: 73. Except at few locations the vertical curves has to be improved as per the standards.

Description

The road has been designed to 100 Kmph and the speed limit should not exceed that limit. A speed limit also needs to be clearly set to allow police enforcement. The road traverses through built up areas and pedestrians are crossing the National Highway. These locations may have significant numbers of pedestrians crossing and the speed limit should be set appropriately to reduce the incidence of pedestrian casualties. From the general safety of road users, it is recommended that the speed limits for the section, which have a design speed of 100 Kmph, should be set to 80kph. The speeds for built up areas with service roads should be 60 Kmph or less. Where the road is in a crossing or walking along the road. Speed limit should be set in discussion with the police, who built up area but no service road is present a lower speed limit should be set, so that traffic is directed to travel slowly, which will be beneficial for pedestrians will enforce them.

Recommendation

A review of speed limits along the project corridor should also be undertaken by the concessionaire with the police authority.

Description

A major cause of collisions is due to stray cattle roaming on roadsides. The project corridor is predominately located adjacent to fields and passes through settlements with livestock. The livestock is often driven along or across the carriageway. The driving of livestock along or across the highway is a potential source of collisions. Motor vehicles driving at a higher speed need to decelerate and change lanes to avoid collisions when livestock is seen driven along the project highway when livestock is being driven across the highway motor vehicles need to stop, which can often result in hard braking to avoid collisions with livestock. Hard braking to avoid livestock may result in rear shunt collision.

The sign should be erected where there is danger due to farm animals or cattle crossing on the road. The sign should not be used simply because animals are driven along or across the road at infrequent intervals but should be used where they cross or are driven alongside the highway regularly. Consider the installation of fences alongside carriageway to restrict access to carriageway except for agreed access points. Also consider planting vegetation that discourages grazing in the median and also alongside the road. Develop an operational plan after discussion with farmers and livestock owners to minimize the safety risk as far as practicable.

Description

It has been observed that vehicles are parked on the highway for varying lengths of time, which can be attributed to lack of understanding of highway etiquettes and sometimes out of necessity as there are no stopping lanes along the corridor in case of the need for a driver break or vehicle breakdown. Parking may also occur because of the lower parking capacity available at the ports. The presence of truck parking alongside the carriageway can result in an increased number of collisions, particularly at night.

Recommendation

Identify and provide adequate parking facilities which are signed and have carriageway markings at appropriate locations for motor vehicles with signs in accordance with IRC: 67-2012.Working with the help of police, ensure that running junctions are kept clear from parked or waiting vehicles. It helps in preventing drivers from parking on the traffic lanes.

Description

All the unauthorized Median openings are to be closed with immediate effect

with the help of police department. Boards showing median openings are to be provided for authorized median openings. Repainting (if required) to road marking paint near median opening is to be carried out. Go Slow boards are to be provided. Speed breakers to feeder road with white repainting are to be provided. T junction board is to be provided board (where it is required) and to check the working of Blinkers. Repainting to Road marking for pedestrian crossing is to be provided. Storage lanes have to be provided for right turning traffic at all median openings.

Liquor shops on highways

The easy availability of liquor leads to drunken driving and to accidents. Presence of wine shops violates the Control of National Highways (Land and Traffic) Act 2002 that prohibits unauthorized constructions along the highways. The State governments have turned a deaf ear to instruction of the Union Ministry of Road Transport and Highways on the removal of liquor shops from the NH. Several road accidents on the highways have been attributed to drunken driving. Road safety cell of Union Ministry asked the State to remove liquor shops on the highways. Road safety cell of the Union Ministry of Road Transport and Highways wrote to the State government pointing out that drunken driving was one of the leading causes of road accidents and asked to take steps for removal of liquor shops along the national highways and stop issuing fresh licenses to liquor vendors to open shops along the highways.

Reflectorized delineators at low embankments up to 3.0 meters height

In low embankments and flat curves, where crash barriers are not provided, these need to be delineated by 1.5 m high reflectorized delineators. One-way reflective road study's shall be provided on edge lines end lane lines on the approach to an intersection or a high level bridge / culvert / ROB etc. with high embankment also. Such studs shall be provided along the sharp curves

- **Speed breakers / rumble strips not provided**

Speed breakers / Rumble strips are provided on the project road highway. In some cases the painted road markings have faded in other cases road markings have not been provided. The visibility of speed breakers / rumble strips affects safety and effectiveness.

Solar blinkers and solar lighting at junctions

The blinkers and lighting are required at the gaps in median and at junctions. Provide adequate solar blinkers at every gap in median and at junctions. Frequent patrolling should be carried out during day and night time to check the performance of traffic management and take corrective measures.

Conclusion

It is safe to say that AASHTO's guidelines on geometric design are crucial to transportation engineering because they emphasize the safety of the driver, providing maximum efficiency of traffic operations and comfort to road users. Each of the design consideration above is promoting the safety of the driver but even so, more research should be conducted in the future so that these guidelines can be improved and so that good design can produce increased traffic safety as ever more users come to our streets and highways.

References:

1. Geometric Design of Highways –American Association of state Highways and Transportation Officials.

2. Intersection informational Guide by Steyn, Hermanus

Codes Referred:

1. IRC: SP: 73-1980
2. IRC 37-2012
3. IRC: 62-1976