

# **MAINTENANCE AND REHABILITATION OF ROADS AND HIGHWAYS**

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# MAINTENANCE AND REHABILITATION OF ROADS AND HIGHWAYS

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## Introduction

After having suffered from the creeping speeds and inferior standards of construction of roads done by the civilian contractors / firms for the past half a century, the government decided to seek assistance of Pakistan Army Engineers i.e. FWO and NLC for rehabilitation of roads of big cities. Lahore, the second largest city of Pakistan, had experienced an unprecedented growth during the last few decades but the authorities responsible for provision and maint of civic amenities could not keep pace with the ever-increasing demand. The continuously growing pressure had culminated in making all previous development activities ineffective and haphazard growth of unplanned localities in the surrounding vicinity had further added fuel to the fire. The over burdened, torn out infrastructure was therefore the obvious out come. The nature and extent of the problem can be gauged from the fact that nearly 80% of the road/street network did not witness any repair/maintenance work during last 20-25 years. This had not only resulted into public inconvenience but also given rise to environmental degradation as a whole. It is pertinent to mention that such conditions were also prevailing in other cities of the country. This was the first ever chance for FWO to work in Urban areas of Punjab, where it had undertaken the rehabilitation of roads of Lahore, Rawalpindi, Islamabad, Faisalabad, Multan, DG Khan, Bahawalpur and Sialkot cities and has successfully completed most of the projects. For construction of urban area roads yet another requirement is higher degree of professionalism, coordination and cooperation between various agencies like the municipality, the police, public and many more departments.

## Important Aspects of Urban Roads

### Surface Drainage

It is very obvious, that layout of country and urban roads is different. Design may vary slightly but general principles remain the same for both types of roads. The distinct feature of design/ layout is the drainage system, which is an essential element of a road structure. Both types have different drainage systems. Major difference in both types obviously is of the kerb stones along the urban area roads, which give side support to the road surfacing and prevent the traffic from getting off the carriageway. The kerb and the road surface near the edge together form a side channel, which carries water, that comes to it from the surface of the road. The water of channel (which is given some longitudinal gradient) is taken away by the underground drainage pipes at the back of kerb line after passing through the gully grating placed at certain intervals along the channel. Drainage of rain /storm water and sewage disposal is the biggest worry of the road designer. If this aspect is not taken care of at the design stage, the problem will continue to

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persist for rest of the life. It has been observed that layers over layers of the surfacing were laid over a period of time without having due regards for the drainage of the area. The raising of road surface level automatically lowers the level of surroundings and adjoining areas thus deny out let to the wastewater of those residents. This water ultimately keeps on accumulating and becomes the source of damage to the road structure. This also causes problem in keeping the requisite Profile Grade/ Permanent Ground Level (PGL).

### **Underground Mains and Services.**

To avoid damage to the road structure after its completion and for the purpose of preventing interference with carriageway in subsequent period, adequate verge space has to be provided on all new roads for the laying of drains, underground mains, cables etc. and their relative positions is determined at the very outset, so that in case of repairs to these services at some later stage, only turf and topsoil is cut, stacked and then filled back after the repairs are over. Where no verges are provided, specially in urban areas, the services may be sited below the footpaths and not below the carriageway so that when the repairs etc to these services are to be done, the carriageway is not disturbed. Widening of road in urban areas, is the most difficult project because shifting of services will take maximum time. It becomes really difficult to follow any time schedule in the process of shifting of services and the slowest moving dept will govern the time schedule for completion of the project. Such things will lead to idling of construction machinery and add to the cost of construction of road. This idling generally takes 30 to 40% of the schedule time. To facilitate subsequent development works without disturbance to road structure, it is always good engineering practice to provide service ducts under pavement. Provision of footpath in urban areas has to be essentially considered for safety of pedestrians. Due to shortage of space, some times the drains are covered under the footpaths or some other services like underground telephone cables, water supply mains, sui gas pipe lines etc may also be placed under the footpaths. In certain areas their outer edges serve as the building lines thus ensuring no encroachments beyond them. However where a footpath is provided, the top of footpath near the kerb is flushed with the top of the kerb and has a little inclination towards the side of kerb so that the water from its surface may flow into the side channel. Footpath may be constructed of stone slabs, bricks, cement concrete but should be of the material not inferior to the material used for road surfacing as otherwise the pedestrians would be tempted to use the road surface in preference to the foot paths. Another type of traffic in urban areas is the pedal cycle, which merits separate path. Cycle way is provided on those urban roads on which the volume of pedal cycle traffic is such that it warrants the construction of cycle track for the safety of pedal cyclists. If pedal cyclist is not restricted to this track, they become great hazard for the fast moving traffic or the pedestrian, in case they decide to move on the footpaths.

## APPROACH TO REHABILITATION

Before proceeding further let us first distinguish between rehabilitation, maintenance and Upgradation.

- a. **Rehabilitation.** Any work undertaken with a view to extending the service life of an existing pavement through the principles of resurfacing restoration, rehandling, reconstruction and recycling will be called rehabilitation. It aims at increasing the functional life of pavement and differs from maintenance.
- b. **Up Gradation.** It is aimed at enhancing the capacity of a road. This necessarily means provision of additional lanes, improvement of road structure, service road, improvement of drainage system etc. Kharian Rawalpindi Additional Carriageway Project is an up gradation projects. Envisaged dualization of Sheikhpura Faisalabad Road is also up gradation.
- a. **Maintenance.** It is to preserve existing pavement so that it may achieve applied loading. It is a process of conservation of road structure to maintain overall performance of any road through out its designed life. It is of two types:-
  - (1) Reactive : Routine/normal which is a costly affair.
  - (2) Preventive : It's offensive in nature and require higher degree of professional foresight. Here a famous saying that "a stitch in time saves nine" is best fitted for better comprehension.

### Rehabilitation Process.

The rehabilitation process encompasses following activities:-

- (1) Resurfacing
- (2) Restoration
- (3) Rehandling
- (4) Reconstruction
- (5) Recycling

### Rehabilitation Strategies

The rehabilitation strategies can be viewed in broad context with reference to three major factors:-

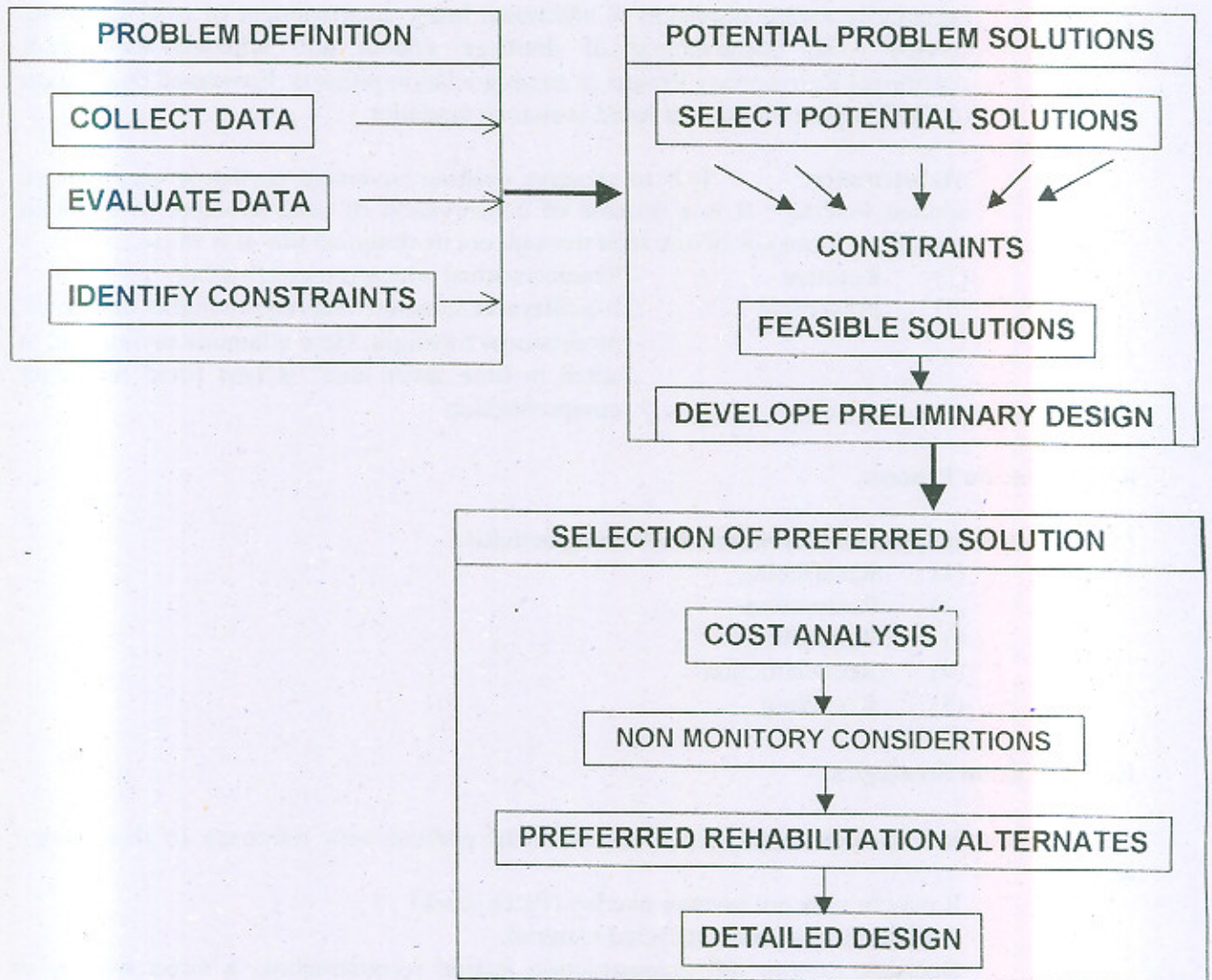
- a. It may or may not involve overlay (Patch work)
- b. Decision to use new / recycled material.
- c. Decision to emp full reconstruction, partial reconstruction, a direct overlay or some combination of overlay and reconstruction.

A wide range of choices is feasible between two extremes ie full depth reconstruction of a pavement and a full overlay. Therefore a careful analysis or judgment must be applied to the project. There are no "right" or "wrong" solutions of pavement rehabilitation problems, but rather better and optimum solutions. There could be many possible solutions, which are cost

effective, have other desirable characteristics and may meet the constraints. Selection of most probable solution is very complex engineering problem, and rehabilitation can be made easier by using logical step by step approach. The fundamentals of the approach are based on necessity to:-

- a. Determine cause of distress or pavement problem i.e problem definition.
- b. Develop list of potential solutions which will properly address the problem.
- c. Select the most feasible and workable preferred rehabilitation solution, which takes care of economic, and other project constraints.

This process is further elaborated in step by step diagrammatic scheme for evaluation of these fundamentals.



## PROBLEM DEFINITION

The process consists of data collection, first field survey, first data evaluation, second field survey, laboratory testing, second field survey and final evaluation and compilation. These steps are highlighted as follows:-

### Data Collection

Suggested steps are:-

- a. **Office Data Collection**      Following data is collected from concerned offices.
  - (1) Location of Project
  - (2) Year of Construction
  - (3) Pavement Design
  - (4) Major Maint Carried out in the past
  - (5) Traffic
  - (6) Material and Soil Properties
  
- b. **First Field Survey**
  - (1) Distress
  - (2) Drainage Conditions
  - (3) Traffic Control Options
  - (4) Safety Considerations
  
- c. **First Data Evaluation & Determination of Additional Data**
  - (1) Evaluate the data
  - (2) List possible solutions based on available data
  - (3) Establish requirement of additional data
  
- d. **Second Field Survey**
  - (1) Detailed measuring and testing
  - (2) Coring and Sampling
  - (3) Deflection tests
  
- e. **Laboratory Testing**
  - (1) Material Strength
  - (2) Moisture Content
  - (3) Composition
  - (4) Density & Gradations
  
- f. **Data Evaluation**
  - (1) Structural Evaluation
  - (2) Functional Evaluation
  - (3) Determination of additional requirement

- g. **Final Compilation** Preparation of final evaluation reports indicating all constraints.

### **Potential Problem Solutions (likely options)**

#### **List Possible Solutions**

Based upon the available data list of possible solutions is prepared. These are those solutions, which address the causes of deterioration and are effective in both repairing the existing distress and preventing its recurrence as much as possible, recurrence. After enlisting the possible solutions quantity of work required for each is determined, since this has bearing on cost.

#### **Apply Constraints**

Generally following constraints are considered:-

- a. Project funding
- b. Traffic control problems
- c. Desirable life after rehabilitation
- d. Geometric design problems
- e. Utilities
- f. Clearances
- g. Right of way
- h. Available equipment materials
- j. Expertise and manpower

Application of particular constraints involves network considerations. The need / priority of total rework should be considered. In certain cases it may be happen that the best rehabilitation approach for a particular road may not be in the interest of network. Hence project constraints, some time limit the number of rehabilitation alternatives available.

#### **Selection Of Rehabilitation Alternates**

A feasible alternative is defined as solution which addresses the cause of distress and is effective in both repairing the existing deterioration and preventing recurrence, while satisfying the imposed constraints. Quick fix and cosmetic treatment must be avoided on deteriorated pavement. Funds spent on such treatments are wasted. If mechanisms causing distress are not treated, the distress will continue to appear and increase its severity. Quick fix solutions are not inherently bad, but are uneconomical.

#### **Development of Preliminary Design**

When all feasible alternates have been conceived , preliminary designs for each of them are prepared, which also include the approximate cost.



## Selection Of Most Feasible Or Preferred Solution

There is no infallible method of selecting the most preferred solution for given project. Rather, selection requires considerable engineering judgement, creativity and flexibility. Following will have bearing on the selection of preferred solutions:-

- a. **Cost Analysis.** This is an important factor in selection of any preferred solution.
- b. **Non Monetary Considerations.** After consideration the cost effects, due regards is given to some of the non-monetary considerations also which are:-
  - (1) Service life
  - (2) Duration of construction
  - (3) Traffic control problems
  - (4) Reliability
  - (5) Constructibility
  - (6) Maintainability

### Preferred Rehabilitation Alternate,

This is selected by first using monetary and then non-monetary factors. Whenever, the cost analysis does not indicate a clear advantage for one of the feasible alternatives, the non-monetary factors may be used to aid the selection process.

### Detailed Design.

Once the preferred rehabilitation method has been selected, detailed design plans, specifications and estimates are prepared. Any changes in cost, design and condition occurring in this phase, may force to re-investigate whether it is still cost effective alternative or otherwise.

### Distress Diagnostics

The distresses of existing road structure can be better diagnosed with the help of following :-

	<u>TRAFFIC LOAD</u>	<u>CLIMATIC / MATERIAL</u>
◇ ALLIGATOR CRACKING	YES	
◇ BLEEDING		YES
◇ BLOCK CRACKING		YES
◇ CORRUGATION		YES
◇ DEPRESSION		YES

◇ LANE / SHOULDER / DROP OFF	-	YES
◇ LANE / SHOULDER SEPARATION	-	YES
◇ LONGITUDINAL / TRANSVERSE CRACKING	-	YES
◇ POLISHED AGGREGATE	YES	-
◇ POTHOLES	YES	-
◇ REVELING / WEATHERING	YES	-
◇ RUTTING	YES	-
◇ SLIPPAGE	-	YES
◇ SWELL	-	YES

#### REDRESSAL OF DISTRESS

A few suggested methods for redressal of distress are given below.

DISTRESS	REPAIR METHOD
◇ ALLIGATOR CRACKING	FULL DEPTH REPAIR
◇ BLOCK CRACKING	SEAL CRACKS
◇ DEPRESSION	LEVEL UP OVERLAY
◇ POTHOLES	FULL DEPTH REPAIR
◇ PUMPING	FULL DEPTH REPAIR
◇ REVELING AND WEATHERING	SEAL COATS
◇ RUTTING	LEVEL UP OVERLAY AND / OR COLD MILLING
◇ SWELL	REMOVAL AND REPLACEMENT

## Functional Conditions

Whatever design may be finalized, it should fulfill the following functional conditions:-

- a. Roughness
- b. Skid Resistance
- c. Appearance
- d. Safety Considerations

### LAHORE ROADS REHABILITATION PROJECT (A ROLE MODEL)

Considering the "Lahore Roads Rehabilitation Project" as a role model of rehabilitation, the experience gained during execution of this project is summarized in the succeeding paragraphs. The constraints and problems encountered during planning and execution stages and how were those resolved, have been explained briefly. The details of projects under taken by FWO are given in table 1 and 2 for phase-I and phase-II respectively. Many small roads have not been shown in the tables.

**TABLE - 1**  
**LAHORE ROADS REHABILITATION PROJECT**  
**PHASE - I**

Serial	Zone / LDA Rds	Name of Roads	Length (Feet)	Width (Feet)	Cost (Rs)
1.	1	Nizam Road	358	17	364755.01
2.	1	Mughlia Park Road	2500	14	160305.20
3.	1	Shamas Abad Road	1361	16	1113442.27
4.	1	Farrukh Abad Road	3074	15	1759224.52
5.	1	Targar Road	3017	14	2756944.32
6.	1	Nain Sukh Road	2500	12	3058996.69
7.	1	Narowal Road & Links	1350	18	1076107.88
8.	1	Goushala Road	1200	20	3054585.85
9.	1	Karim Park Road Goul Ground	2800	20	4134990.49
10.	1	Church Road	1000	15	937559.18

11.	1	Main Bazar Amin Park	1099	18	1636747.23
12.	1	Macca Road Aftab Chowk	2418	20	2434064.61
13.	1	Yasin Road & Links	1817	18	1650907.09
14.	1	Main Bazar Khokhar Town	887	15	709959.02
15.	1	Mehmood Shaheed Road	2500	18	6164697.72
16.	1	Block No 1 & 2 Karim Park	4172	20	4950807.25
17.	1	Kacha Ravi Road	3000	20	3898928.61
18.	1	Bagh Munshi Ladha To Kasur Pura	1950	16	2092702.46
19.	1	Tariq Street Karim Park	975	20	1304507.46
20.	1	Farooq Gunj Road (Khuta Pully)	482	20	246197.22
21.	1	Vandala Road	2388	16	2997824.75
22.	1	Sher Shah Road	3640	20	4791848.14
23.	1	Main Bazar Yousaf Park	2376	20	1987283.51
24.	1	Qazafi Road	1635	15	1373158.80
25.	1	Main Bazar Malik Park	1092	20	1588555.12
26.	1	Masoom Shah Road	1453	20	740369.50
27.	1	Hafeez Road Link Ibrahim	816	16	1224196.51
28.	1	Kokab Street	715	20	858936.17
29.	1	Rashid Road	1950	22	3123592.36
30.	1	Macca Road Upto Kasur Pura	2236	18	2986823.98
31.	1	Islam Nagar Road	991	16	744449.98
32.	1	Rathore Park Road	988	20	1361718.34
33.	1	Gillani Park Road	943	14	1459070.14
34.	1	Hamuyum Street	504	20	687777.18
35.	1	Street No 9 Amin Park	1521	18	1635399.25
36.	1	Jamia Ghosia Masjid Road	1027	20	1697364.78

37.	1	Mujahid Road	949	20	900165.07
38.	1	Toheed Road	1138	20	1785571.13
39.	1	Amir Road	2018	22	2366819.31
40.	1	Subedar Road	328	20	241615.00
41.	1	Street of Hafeez Road	1573	20	1356366.29
42.	1	Younis Shaheed Street	634	20	1569198.62
43.	1	Sufi Street	367	20	286788.91
44.	1	Qadari Street	367	20	319903.56
45.	1	Umer Colony Upto Khokhar Town	930	15	838334.30
46.	1	Streets of Khokhar Town 1 To 9	3832	20	3139628.88
47.	1	RCC Slab Badami Bagh	731	25	3385634.47
48.	1	Sheikh Yousaf Street	303	18	464852.56
49.	1	Macca Road	1895	20	3136227.16
50.	1	Ibrahim Road	1544	20	2034636.73
51.	1	Siddique Pura Drain Road	10231	52	1420288.28
52.	1	Bokhara Road	290	20	211564.81
53.	1	Amin Park Street No 4,5	1381	15	2757551.88
54.	1	Lajpat Road Street No 6-A	770	12	583200.78
55.	1	Madni Road	325	16	375557.34
<b>TOTAL:</b>					<b>99938703.67</b>
56.	2	Iqbal Road	2417	30	2016579.92
57.	2	Allah Buksh Road	1082		181894.05
58.	2	Tripple Road 1,2 & 3.	2828	45	5825533.86
<b>TOTAL:</b>					<b>8024007.83</b>
59.	3	Disposal Road	1312	30	502225.69
60.	3	Tajpura Road Ghaziabad	2870	18	4979591.40

61.	3	Main Bazar Mustafa Abad	859	25	590471.41
62.	3	Gunj mughal Pura Road	3200	16	2954338.77
63.	3	Chalk Factory (Mustafa Abad)	1450	22	726549.22
64.	3	Amratsari Mohallah Road	1509	14	979893.94
65.	3	Account Colony Road	1791	20	784814.08
66.	3	Dargha Road (Mustafa Abad)	1804	18	3867586.37
67.	3	Godown Road Mughal Pura	2526	20	2452375.75
68.	3	Main Fateh Gurh Road	1213	22	2367156.48
69.	3	Darse Road (Additional Portion)	904	14	1223099.62
70.	3	Mian Muhammad Din Road	997	14	598632.21
71.	3	School Road Mustafa Abad	1443	29	1288907.38
72.	3	Muslim Colony	492	12	91587.75
73.	3	Sultan Mahmood Road	17151	15	9813105.95
74.	3	Harbans Pura	1394	18	4297835.00
75.	3	Wara Sattar Shah Road	1499	19	854514.77
76.	3	Dispensary Road Dars Baray Mian	820	16	1260775.48
77.	3	Nawazish Road Garhi Shahu	803	14	285160.23
78.	3	Nusrat Colony Road	2706	16	886539.00
79.	3	Altaf Colony Road	4297	24	1512311.37
80.	3	Shalimar Larex Road	1197	20	1673294.00
81.	3	Ithad Colony Road		12	3724992.96
82.	3	Veetman Road	387	16	2337482.48
83.	3	Rana Inam Road	1312	10	1378716.40
84.	3	Khawaja Ahmed Ahsan Road			6874300.93
85.	3	Service Canal Road Mughal Pura.	3198	12	5764481.66
86.	3	Ghazi Rd To Pind Jhalaran Road Ph - I & II.	12404	24	29013228.95

TOTAL:					96529257.08
87	4	Main Bazar Akbari Mandi	964	20	539457.63
88.	4	RCC Slab Gen Bus Stand Ent & Exit	3050	35.50	30808694.18
89.	4	Neeli Masjid Road	557	20	628908.21
90.	4	Gonga Sweet House Road (Out Side)	646	18	576228.53
91.	4	Timber Market	902	15	1127577.03
92.	4	Qila Lachman Singh	1400	24	454188.07
93.	4	Approach Road Badshahi Masjid	2109	19	1863173.74
94.	4	Al Faisal Shaheed Road	2053	21	112173.91
95.	4	Bazar Sheikhpurian Road	1200	12	1038009.68
97.	4	Judge Muhammad Latif Road	446	19	188499.54
98.	4	Thathi Mullah Noor Mullah	1400	30	21902.76
99.	4	Fort Road	3116	24	2480213.13
100.	4	Newan Chait Ram Road	1361	16	511933.52
101.	4	Bokhari Chowk To Said Mitha	2585	17	510334.98
102.	4	Bokhari Chowk To Pani Wala Talab	1669.9	18	278481.68
103.	4	Bokhari Chowk To Lohari Gate	685	24	324817.55
104.	4	Tarranum Chowk To Bhatti Police Station	2526	24	1717659.55
105.	4	Ucha Cait Ram Road	902	24	970131.74
106.	4	Surjan Singh To Delhi Gate	3254	20	1540428.13
107.	4	Tarranum Chowk To Pani Wala Talab	1500	21	1223978.58
108.	4	Tarranum Chowk To Fort Road	237	26	336903.55
109.	4	Janda Chowk To Mori Gate	387	22	237445.89
110.	4	Kisra Bazar	216	10	65477.57
111.	4	Janda Chowk To Pani Wala Talab	1669.9	17	498654.28
112.	4	Tarranum Chowk No.1 (Link To Fort Rd)	492	24	54777.72

TOTAL:					48110051.15
113.	LDA Rds	Zahoor Ellahi Road (Left & Right Side)	4857	24	8514829.86
114.	LDA Rds	Zafar Ali Road (Left & Right Side)	5868	24	13401331.06
115.	LDA Rds	Shalimar Link Road	7708	65	65561368.26
116.	LDA Rds	Durand Road	3412	28	18071898.15
117.	LDA Rds	Liberty Market (Left & Right Side)	1148	17	6015784.40
118.	LDA Rds	M.M Alam Road	1312	45	4279280.59
119.	LDA Rds	Lower Mall	11729	50	77098534.50
120.	LDA Rds	Main Boulevard SVC Road (L & R Side)	25700	15	72923144.96
121.	LDA Rds	Ghazi Road	21325	52	143697739.70
122.	LDA Rds	Main Boulevard Gulberg	25700	50	176105559.70
123.	LDA Rds	Grand Trunk Road	11070	66	11109317.10
124.	LDA Rds	Mini Market To Jinnah Industrial Road (Left & Right Side)	2676	25	2516666.64
125.	LDA Rds	Zahoor Ellahi Link Road	1443	13	650516.60
126.	LDA Rds	Fawara Chowk To Zafar Ali Road	1610	14	539444.17
127.	LDA Rds	Shah Jamal Round About	4547	24	496321.26
128.	LDA Rds	Shah Jamal Street #. 1 To 6	4875	21	4552006.87
128.	LDA Rds	Fawar Chowk To Sher Pao Bridge SVC Road	1351	11	1030041.03
130.	LDA Rds	Kashmir Road	2224	32	409909.91
131.	LDA Rds	Bank Road	2263	30	6545567.65
TOTAL:					613519262.41

G.TOTAL:

866121282.14



**TABLE - 2**  
**LAHORE ROADS REHABILITATION PROJECT**  
**PHASE II**

Serial	Zone / LDA Rds	Name of Roads	Length (Feet)	Width (Feet)	Cost (Rs)
1.	1	Abdul Rasheed Toheed Rd Site	656	16	627,000.00
2.	1	Abdul Sattar Road	1381	16	7,069,000.00
3.	1	Addl Portion Siddique Pura	4922	24	12,004,000.00
4.	1	Ahmed Park	1500	18	5,541,000.00
5.	1	Ahmed Park Street # 10	499	26	2,113,000.00
6.	1	Ahmed Park Street # 12	698	18	2,572,000.00
7.	1	Al Tamash St No. 4 Ashan St No. 5	279	14	244,000.00
8.	1	Ali St.No. 9	604	24	682,000.00
9.	1	Allam Iqbal Links St No. 10	525	18	523,000.00
10.	1	Allam Iqbal Links St No. 11	270	20	238,000.00
11.	1	Allam Iqbal Links St No. 8	528	19	477,000.00
12.	1	Allam Iqbal Links St No. 9	466	18	421,000.00
13.	1	Allam Iqbal Rd	600	28	805,000.00
14.	1	Amer Rd With Bilal Gunj Karimia Rd	574	21	562,000.00
15.	1	Amin Park Link St No. 6	492	22	526,000.00
16.	1	Amin Park Link St No. 7	492	22	515,000.00
17.	1	Amin Park Link St No. 8	492	25	574,000.00
18.	1	Aziz Khardar Road	1611	20	5,928,000.00
19.	1	Aziz Road Ahmed Prk	2034	18	7,486,000.00
20.	1	Bagh Munshi Ladha Street 1,4,7&15	3081	18	11,337,000.00

21.	1	Carpeting Street Ravi Colony	1382	16	5,083,000.00
22.	1	Ch. M. Ali St No. 5	453	18	409,000.00
23.	1	Ch. M. Saleem St No. 3	396	18	335,000.00
24.	1	Chowk Hasan Ara Road	1000	16	3,682,000.00
25.	1	Christian	220	18	192,000.00
26.	1	Consular House St No. 11	492	18	408,000.00
27.	1	Faisal St No. 22	400	18	329,000.00
28.	1	Faisal St No. 6	396	18	329,000.00
29.	1	Ghazi Girls High School St No. 10	607	24	681,000.00
30.	1	Ghazi Park Wolkson Road	1680	18	6,182,000.00
31.	1	Ghazi St No. 5	740	20	689,000.00
32.	1	Ghoia St No. 23	880	18	775,000.00
33.	1	Ghori St No. 4, Sewer St No. 12	272	18	213,000.00
34.	1	Goshala Qbristan	1772	16	6,520,000.00
35.	1	Hajvari Mohallah St No. 10	347	16	501,000.00
36.	1	Hajvari Mohallah St No. 12	479	15	444,000.00
37.	1	Hajvari Mohallah St No. 13	410	14	363,000.00
38.	1	Hajvari Mohallah St No. 2	433	12	175,000.00
39.	1	Hajvari Mohallah St No. 3	312	18	181,000.00
40.	1	Hajvari Mohallah St No. 4	354	15	328,000.00
41.	1	Hajvari Mohallah St No. 5	380	16	351,000.00
42.	1	Hajvari Mohallah St No. 9	347	17	185,000.00
43.	1	Haq Char Yar St No. 33	452	18	399,000.00
44.	1	Imam Bakhsh St No. 15	722	16	582,000.00
45.	1	Iqbal St No. 2	771	18	685,000.00
46.	1	Jamia Masjid Takya Shade Moni Rd St No.3	272	20	352,000.00

47.	1	Jamia Street	656	16	2,415,000.00
48.	1	J-Block St	985	22	1,111,000.00
49.	1	K-3 Block St	246	20	319,000.00
50.	1	Kardar Road	1969	18	7,244,000.00
51.	1	Karim Mandi Masjid Road	1968	18	7,244,000.00
52.	1	Karim Park, Rehmand.Prk Block No 3	1792	20	6,592,000.00
53.	1	Karimia Link Rd St No. 1/A	492	20	607,000.00
54.	1	Karimia Link Rd St No. 11/B	230	20	284,000.00
55.	1	Koh-e-Noor Road	1312	20	4,894,063.00
56.	1	Lali Masjid Kasur Pura	984.25	14	3,622,000.00
57.	1	Latif Park Street 13	1050	16	3,864,000.00
58.	1	Link Abdul Sattar & Abdul Qayyum Rd	767	36	3,847,854.00
59.	1	Link Aziz Road Kardar Park	1772	12	6,520,000.00
60.	1	Link Perr Makky St No. 2	121	14	54,000.00
61.	1	M. Aslam Khan St No. 25	328	18	292,000.00
62.	1	M. Mahmood Ul Hassan St No. 4	390	18	347,000.00
63.	1	M.M Model School St No. 24	430	18	356,000.00
64.	1	M.M Siddique St No.19	463	18	552,000.00
65.	1	Main Bazar Kasur Pura Link	1837	18	6,761,000.00
66.	1	Main Bazar Takia Saddar Shah	318	24	384,000.00
67.	1	Main Kardar Park Main Mohni	1906	20	7,015,000.00
68.	1	Main Mohni Road	2954	18	2,421,000.00
69.	1	Main Rd Salamat Pura Block I.D Hospital	1182	24	423,000.00
70.	1	Mali Pura Road	247	18	97,779,000.00
71.	1	Mian Karimia Rd Block No. 9	2297	24	3,112,000.00
72.	1	Mian Karimia Rd Block No. 9 Links St No. 10	492	16	506,000.00

73.	1	Mian Karimia Rd Block No. 9 Links St No. 12	480	20	591,000.00
74.	1	Mian Karimia Rd Block No. 9 Links St No.9	196	22	206,000.00
75.	1	Mian Muhammad Aslam Road (Peco Factory To Data Nagar Over Head Bridge)	4388	20	20,902,000.00
76.	1	Minhaj St No.21	312	24	346,000.00
77.	1	Moin Road Behlwana Park Link	2887	12	10,624,000.00
78.	1	Mughal St No. 32	180	16	199,000.00
79.	1	Muhammadia St No. 1	394	18	356,000.00
80.	1	Mustafa Msjid St No.19	530	22	537,000.00
81.	1	Niaz St No. 7	489	18	442,000.00
82.	1	Opal St No. 21	425	18	385,000.00
83.	1	Perr Makky Main Rd	446	15	188,000.00
84.	1	Professor M. Yahya	665	16	627,000.00
85.	1	Quaid-E-Azam Street	984.25	18	3,622,000.00
86.	1	Rasheed Rd	656	18	200,000.00
87.	1	Ravi Link Road	8202	28	60,690,242.00
88.	1	Salamat Muhallah St No. 9	141	18	122,000.00
89.	1	Shah Jahan Rd	728	15	659,000.00
90.	1	Shah Jahan Road	840	20	3,091,000.00
91.	1	Shair Ali Mohni Rd St No. 1	590	16	423,000.00
92.	1	Shash Mohallah	1116	20	4,105,000.00
93.	1	Sheeda Gung St No. 29	194	28	24,100.00
94.	1	Sheesh Mahal Park Shah Jahan Rd Front of Dgree College St No. 1	1066	24	1,445,000.00
95.	1	Sheesha Walli Masjid St No. 26	594	20	478,000.00
96.	1	Sheikh Tahir Hussain St No. 9	515	22	566,000.00
97.	1	Siddique Pahalwan To Quarter Umer Hayat	1400	16	5,155,000.00

98.	1	South & North St Ch. Amjad Nazir Site St # 20	460	18	408,000.00
99.	1	Street # 1,2,3 Amin Park	2654	16	7,767,000.00
100.	1	Street # 7 Abadi Sheikhan	1352	18	4,974,000.00
101.	1	Tandoor Walli St No. 10	903	20	910,000.00
102.	1	Toheed Links St 1/A	1082	12	92,000.00
103.	1	Toheed Links St 2/A	164	18	203,000.00
104.	1	Toheed Links St 3/A	190	8	114,000.00
105.	1	Toheed Links St 4/A	180	18	223,000.00
106.	1	Toheed Links St 5/A	145	20	182,000.00
107.	1	Toheed Links St 6/A	118	18	128,000.00
108.	1	Toheed Links St 7/A	164	16	175,000.00
109.	1	Toheed Links St 8/A	246	18	304,000.00
110.	1	Toheed Links St 9/A	331	18	392,000.00
111.	1	Usmani Bazar Bilal Gunj	410	22	402,000.00
112.	1	Yaseen Khan St No. 3	328	18	272,000.00
113.	1	Zumard St No. 26	367	20	338,000.00
<b>TOTAL:</b>					<b>392,050,259.00</b>
114.	2	Allama Iqbal Road	2592	16	9,538,000.00
115.	2	Aziz Road	1640	16	4,846,000.00
116.	2	B&C Block Road	1154	24	6,290,000.00
117.	2	Central Road	1378	20	5,071,000.00
118.	2	Chiragh Park Road Shad Bagh	2237	24	529,000.00
119.	2	Imam Ghazali Road	1313	18	4,829,000.00
120.	2	Kashmir Road	4465	16	5,330,000.00
121.	2	Main Bazar Faiz Bagh	1172	16	4,450,000.00
122.	2	Main Bazar Wasan Pura	1710	18	6,278,000.00

123.	2	Makhan Pura Road	1549	20	5,697,000.00
124.	2	Mehboob Road	1664	20	4,846,000.00
125.	2	Naulakha Park Road	1247	18	458,800.00
126.	2	Pir Ronky Park St	1969	18	3,488,000.00
127.	2	Saddique Pura Additional Rd	16404	18	10,219,727.00
128.	2	Saddique Pura Main Bazar	2543	20	4,228,000.00
129.	2	Tripple Rd (Civil Work) Kerb Stone	2943	27	2,762,000.00
<b>TOTAL:</b>					<b>58,162,800.00</b>
130.	3	Altaf Road Ext	1752	18	6,300,000.00
131.	3	Bahar Shah Road	3662	24	6,321,451.00
132.	3	Infantory Road (Mian Mir)	2297	24	8,451,000.00
133.	3	Iqbal Rd (Soling)	2418	16	1,100,000.00
134.	3	Kalandar Pura Road	3340	24	38,451,000.00
135.	3	Lakho Dhairo Road Ph-I & II	3280.72	22	9,975,000.00
136.	3	M E T I & II	5250	20	19,316,000.00
137.	3	Madho Lal Hussain Road	985	20	3,622,000.00
138.	3	Shadi Pura (Soling)	1378	18	5,350,000.00
139.	3	Shama Park Soling	1037	16	2,720,000.00
140.	3	Sultan Mahmood	797	20	17,072,000.00
<b>TOTAL:</b>					<b>112,378,451.00</b>
141.	4	Shah Alam To Rang Mahal Link	3610	24	31,270,000.00
<b>TOTAL:</b>					<b>31,270,000.00</b>
142.	LDA	Azadi To Niazi Chowk	6562	16	43,355,000.00
143.	LDA	Feroze Pur Road	11564	42	299,844,331.00
144.	LDA	Ghalib Market Road	125	6.5	729,608.00
145.	LDA	GT Road Shalimar Garden To Darogha Wala (Ph-II)	7470	36	7,894,517.00

146.	LDA	Khokhar Road	2352	18	12,057,421.00
147.	LDA	Koh-I-Noor (PCC) Road	1673	16	6,157,000.00
148.	LDA	Noor Road	5453	20	2,721,585.00
149.	LDA	Peco Road	2651	36	16,048,121.00
150.	LDA	Shalimr Link Rd Add Portion Ext (Mughal Pura Bridge To Sadar Chowk)	4406	36	52,188,718.00
<b>TOTAL:</b>					<b>397,641,301.00</b>

**G.TOTA     991,502,811.00**  
**L:**

### **Data Collection and Co-ordination with Other Agencies**

Type of data required for planning of construction / rehabilitation of any road has already been discussed. Here the difficulties encountered during data collection have been elucidated. While working on roads rehabilitation / reconstruction, it is not only the reconstruction agency but there are a lot many other agencies also, on which the progress of project will depend. In Lahore following agencies were involved.

- a. Metropolitan Corporation Lahore (MCL)
- b. Lahore Development Authority (LDA)
- c. Traffic Engineering and Planning Agency (TEPA)
- d. Pakistan Telecommunication Corporation Limited (PTCL)
- e. WAPDA
- f. Water and Sanitation Agency (WASA)
- g. Sui Northern Gas Pipe Line Limited (SNGPL)

When upgradation / rehabilitation on any road is on the anvil, these departments also start planning for execution their development works independently. A detailed coordination is thus required between all the departments for execution of urban area road rehabilitation project. During rehabilitation process, it is not only the road constructing agency which carries out work but other departments also share the burden in similar proportion. So the pace of progress will depend upon the pace of the slowest working department. Work on Main Boulevard was delayed minimum by four weeks due to non-shifting of electric poles by WAPDA. At that time summer season was at peak and load shedding could not be carried out for longer stretches of time due to inconvenience to public. Similarly, when Main Boulevard was to be upgraded, Sui Northern Gas Pipeline Limited decided to lay a 12" dia pipe along the road which was done and future expansion of gas network is now possible without damaging the road. The completion schedule hence is disturbed due to other departments.

## Mode of Coordination

Lahore Roads Rehabilitation Project was quite complex assignments. At the start of the project a coordination meeting used to be held daily to discuss the problems and coordinate the action of the various departments. But after two months it was reduced to twice a week. After one year it was further reduced to once a week. The meeting used to be chaired by the Lord Mayor Lahore and following used to participate:-

- a. Commissioner Lahore
- b. ADC (G) for determination of property line
- c. Director Town Planning MCL
- d. Chief Engineer MCL
- e. Project Managers MCL
- f. DIG Traffic
- g. Elected representatives on required basis.
- h. Representatives of Executing Agencies (FWO), TEPA, PTCL, SNGPL, WAPDA, WASA, LDA, NES PAK (Consultants) and C & W.

## Design Period

In urban roads rehabilitation / up gradation, design must base on maximum design period because frequent rehabilitation can not be under taken due to following factors:-

- a. Inconvenience caused to public due to construction activities.
- b. Involvement of relocation / shifting of utility services.
- c. Dismantling and provision of civil works like footpath, side drains and gully gratings etc is an expensive exercise.

## Working Out Projected Traffic

Knowledge of projected traffic is most important factor for the geometric design of urban road. Unlike country roads, it is difficult to predict the traffic pattern for urban roads due to following reasons:-

- a. With improvement of one segment of network the pattern of traffic will change in the entire network. Recent example is the coming up of university underpass where traffic along canal road has increased. The improvement of Main Boulevard Gulberg has attracted almost more than four times the traffic, which was there earlier on.
- b. With coming up of commercial areas traffic increases in certain areas of the city. Frequently addition of commercial areas makes it difficult to ascertain projected traffic.

## Drainage

Casa Grande, the father of soil mechanic has termed good drainage as the foremost principle of road construction. In case of urban roads, drainage poses most serious problem. There is general



tendency to dispose of road run into nearest sewage system through gully gratings or side drains. If sewage system runs alongside the road, disposal is through gully grating. If sewage system does not run alongside the road, water is collected by side drains into sewage system. The problems in Lahore was that existing sewage system had been further overloaded due to rapid population growth, thus displaying limited capacity to take road water. As the upgradation of roads takes place, run off increases requiring more capacity by the sewage system. Logical conclusion is upgradation of sewage system alongwith roads. Which is very costly proposition. Here critical decision regarding selection of type of pavement is made. Construction of rigid payment in General Bus Stand area Badami Bagh had to be under taken because of poor drainage of the area. Besides rehabilitation / upgradation, the drainage system also needs to be upgraded like upgradation of pumping station on Guru Mangat Road was executed.

### **Geometric Design**

The proposed geometric design for most of the roads underwent frequent changes especially with reference to finished road level. No road could be dealt with separately or in isolation. As routine rehabilitation results in raising of road level. Hence other roads joining this particular under construction road or adjacent streets become lower. This disturbs the drainage system of entire area. A detailed survey becomes the requirement to sort out the drainage problem of entire network, thus consumption of extra time and resources. When it was not possible to take care of the entire area, solution was found in providing gully gratings at junction points of roads.

### **Compaction along the Side Drains**

While carrying out rehabilitation of roads in urban areas, in an endeavor to widen the road to maximum possible extent, road pavement generally touches the side drains constructed to take storm water. The compaction of sub base and base results in damage to side drain. Compaction is either required to be carried out with walk behind compactors or drain is constructed after the construction of road. While planning of such work this aspect must be kept in mind. Shalimar Link Road is one such example where road pavement is touching the side drain.

### **Traffic Control**

Traffic control turned out to be a major problem in urban area road construction. To avoid inconvenience to the public on the roads under repair / rehabilitation, more elaborate and detailed arrangements are required. Working timings have to be adjusted to avoid peak traffic hours. Efforts were made to block only a portion of road rather than closing its entire length. Proper sign posting was pre requisite to traffic control. For example if work was being carried out Main Boulevard sign posting had to be carried out as shown on the screen.

### **Absolute Blocking of Traffic**

There was a requirement to block the road completely when paving was in progress. Cyclist, motor cyclist and pedestrians, normally disturbed the wires fixed for sensors of the paver and placing of point men had to be done where proper sign posting did not work. It was ultimately resorted by placing of concertina, which prevented pedestrians and cyclist from moving over

freshly, laid asphalt. Many scuffles took place with public, which forced blocking the complete area to stop people disturbing the censor system. Such things are likely to happen quite frequently in urban areas.

#### **Assistance from Local Traffic Police**

Essentially required assistance from traffic police in terms of pointmen and sign posting has not been forthcoming. Although it was indicated in the agreement that traffic diversion was the responsibility of the sponsor, the diversion of traffic to undertake the road construction was normally done by the executing agency. Mostly FWO had to regulate the traffic therefore this aspect took a lot of time and effort thus extra financial burden.

#### **Service Corridor**

Generally the utility services like water supply line, sui gas line and PTCL lines run along the road. Often their repair is required, that means digging along the road will have to be carried out, whenever fault develops in these services. Effort has therefore been made to provide service corridor along minimum one side of the road. The top surface of service corridor is normally brick paved so that after removal of bricks the services can be repaired and bricks re-laid, without damaging the road pavement.

#### **Provision of U-turns**

With rehabilitation /upgradation speed of traffic increased considerably, thus causing large number of accidents on U-turns. Thus it was considered that the no of U-turns be reduced. But the public convenience demanded more number of U-turns be provided. This controversy remained active through out the project on Shalimar Link Road in a length of roughly 2.8Km. There were approximately 8 U-turns but now these have been reduced to 4. This is very sensitive aspect of urban area road construction. On Main Boulevard Gulberg, U-turn was eliminated in front of PACE, but it has caused a lot of difficulty to public especially to pedestrians. People of the area went to court and the case is still pending. Such things waste lot of time and projects get delayed unnecessarily.

#### **Streets Lights**

Provision of streetlights requires proper designing under given parameters of light requirement on the road. This is also quite time consuming and costly activity. Roughly Rs 5.000 million are required to provide street light of standard that has been provided at Jail Road, G.T Road and Main Boulevard Gulberg.

#### **Encroachment Removal**

A unhealthy culture of encroachments existed in Lahore when the project was started. The removal of encroachments is the main difficulty, which hampered the progress of project considerably. A great deal of difficulty was experienced in exploring accurate record of Government property. There were two reasons for it. First the record was not accurate. Second,

the encroachment had been made with the consent of concerned town planner. With the passage of time Town Planner had declared most of the obvious encroachments as the legal occupation, thus creating problems for the executing agencies. To arrive at correct decision a lot of time was wasted. Most of petrol pumps, which were removed for widening the road, were infact not encroachments but those areas had been leased out by LDA for a certain time period. The lease agreement carried a clause that whenever required the occupant will vacate the allotted space hence it was under this agreement that approximately ten petrol pumps were demolished on Jail Road for its Upgradation.

### **Disposal of Malba**

The problem of PGL has already been discussed which is usually disturbed by adding layers of surfacing during the process of repair/ maint of roads and causes a lot of inconvenience to the resident of the area. If PGL is to be maint following the good engineering practices, then new layers is laid after removing the existing damaged surface. Scarification / milling created another problem for disposal of Malba. It is really difficult to dispose off malba in urban areas as it has to be transported to very far off distances, which becomes too costly.

### **Land Acquisition for Extension**

To improve the existing intersections and add additional lanes, land has to be acquired which are time consuming as well as costly affair.

### **Upgradation of Existing Drains**

It is very difficult to upgrade the existing drain without construction of diversion when the road structures / traffic is not to be disturbed. No construction can be under taken in the running sewage.

### **Supply of Construction Material in Interior Streets / Roads**

Due to rush of traffic in the cities heavy traffic is not allowed to enter the interior areas and supply of construction material has to be restricted to night hours. More over narrow streets posed problems to heavy trucks carrying construction material.

### **Service Road**

To separate the slow moving and local traffic from the fast moving and through traffic, service roads are required to be provided along the main roads.

### **Beautification**

Though proper markings and lighting arrangements add to the beauty besides serving other purpose, yet there is requirement for adding some green belts and water structures along the roads for better esthetics. The aspect of their subsequent maint during the period of their designed life must be born during planning and execution stages.

## Safety of Public Property

Usually safety of the adjoining buildings and structures along the roads is ignored, while undertaking excavation or employing heavy machinery like vibratory road rollers due to which those can be damaged. This also calls for selection of appropriate time /season when rainwater may not affect the ground moisture during construction.

## CONCLUSIONS

Today in the world, vehicles rolling over highways, roads and streets are the principal means for transporting persons and goods. In Pakistan, their importance to intercity passengers and freight movement can be visualized by any one who has to travel in remote areas and when most of the timing house hold items are on the wheels. Efficient movement of agricultural products, access to medical attention and good ability to transport raw materials and finished products are all essential if they are to raise the living standards above the subsistence level. None of these can be accomplished when transportation relies, on what people or animals can carry on their backs or pull in carts or wagons. Maintenance and rehabilitation of roads and high ways is thus equally if not more important than their construction. Rehabilitation of roads has always been the need of the fast developing cities / towns, more so in old cities of our country, where non-availability of adequate funding has kept this aspect neglected. Government of Pakistan has realized very late but it is not too late and has taken positive step towards better future. Rehabilitation of roads in major cities of Punjab should not be taken as a one-time measure only but should remain a continuous process in consonance with the growth of population and traffic. This process needs regular evaluation and development with professional approach. Drainage system of the road network has also to be critically and deliberately planned to avoid damage to road structures. It must be prayed and expected from all citizen of this country to achieve highest standard of knowledge to evaluate, plan and execute such projects with highest degree of skill and professional approach.

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