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DESIGN OF RIGID PAVEMENT FROM MATI TO SHRI RAMSWAROOP MEMORIAL UNIVERSITY, BARABANKI.

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ABSTRACT-The increasing traffic density at Lucknow Deva road has emancipated the need of constructing a rigid pavement in place of the present flexible pavement and simultaneous widening of the road so as to provide to the traffic load. The current condition of the flexible pavement is not optimal and is getting dilapidated day by day due to the consistent heavy vehicle movement. Hence, towards the fulfilment of the purpose a small patch of road was designed from Mati to Sri Ramswaroop Memorial University, Barabanki.

Keywords-pavement, widening, loads, traffic density

I INTRODUCTION

TYPES OF PAVEMENTS
- Flexible pavements
- Rigid pavements

DESIGN PARAMETERS OF RIGID PAVEMENT (Length1000m)	
CBR (soaked) of subgrade	5%
Present traffic	1786 CVPD
Concrete grade(PQC)	M40 N/mm^2
Dry lean concrete sub base	150mm DLC must be laid before casting C.C slab (M15 N/mm^2)
Design thickness of CC slab	280mm
Types of cement to be used	OPC43 grade
Panel size	L=7000mm, B=3500mm
Flexural strength(f_{cr})	$55kg/cm^2$
Proposed diameter of dowel bar (b)	32mm
Number of dowel bars in each panel	4
First dowel bar is placed at a distance	150mm
Designed spacing b/w dowel bars	250mm
Designed length of dowel bars	500mm
Density of concrete	$2400\ kg/m^3$
Allowable tensile stress in deformed bars	$2000kg/cm^2$
Allowable bond stress for deformed tie bars	$24.6\ kg/cm^2$
Deformed tie bar diameter	12mm
Length of tie bars	640mm
Spacing of tie bars	640mm
Thickness of GSB	200mm
Thickness of WMM	200mm

II METHODOLOGY

DETAILED SURVEY

- Temporary bench mark are fixed at interval of about 250 meter and at all drainage are under pass structures .Levels along the final centre line should be taken earth work calculation and drainage details are to be worked out from the level notes. The cross-section levels taken up to the desired width at interval of 50 to 100meter in plain**.**

- The data during the detailed survey should be elaborate and complete for preparing details, design and estimate of the project.

EXISTING REDUCE LEVEL OF LANE -1

		LEFT		CENTRE		RIGHT
S.NO.	CHAINAGE/OFFSET(km)	C1-1.75	C1-1	C1	C1-1	C1-1.75
1	0.000	98.388	98.401	99.670	99.805	99.890
2	0.025			99.440	99.804	99.849
3	0.050	98.519	98.986	99.819	99.829	99.852
4	0.075	99.291	99.423	99.584	99.791	99.884
5	0.100	99.234	99.591	99.541	99.777	99.831
6	0.125	98.993	99.466	99.656	99.688	99.803
7	0.150				99.652	99.744
8	0.175	100.640	100.629	100.629	100.733	100.740
9	0.200	99.912	100.272	100.552	100.850	100.810
10	0.225			100.703	100.850	100.879
11	0.250	100.248	100.510	100.772	100.944	101.086
12	0.275	100.970	101.046	101.044	101.005	101.059
13	0.300	100.748	100.810	100.879	101.236	101.015
14	0.325	101.031	101.041	101.054	101.073	101.109
15	0.350	100.824	100.997	101.074	101.163	101.167
16	0.375	100.889	100.977	101.219	101.064	101.102
17	0.400	100.782	100.796	101.022	101.038	101.150
18	0.425	100.905	100.816	100.984	101.048	101.165
19	0.450	101.024	101.034	101.097	101.156	101.294
20	0.475	100.789	101.062	101.192	101.260	101.312
21	0.500		101.183	101.219	101.267	101.285
22	0.525	100.812	101.235	101.224	101.232	101.336
23	0.550	101.252	101.182	101.166	100.955	100.766
24	0.575	100.187	100.876	101.106	101.142	101.238
25	0.600	100.875	100.964	101.010	101.065	101.127
26	0.625	100.620	100.854	101.089	101.104	101.137
27	0.650	100.894	100.970	100.994	101.037	101.148
28	0.675		101.057	101.134	101.121	101.160
29	0.700	100.375	100.808	101.168	101.138	101.186
30	0.725	101.015	100.985	101.126	101.166	101.193

EXISTING REDUCE LEVEL OF LANE-2

		LEFT		CENTRE	RIGHT	
S.NO.	CHAINAGE/OFFSET(km)	C2-1.75	C2-1	C2	C2-1	C2-1.75
1	0.000	99.890	99.960	99.965	99.980	99.990
2	0.025	99.849	99.905	99.971	100.005	100.030
3	0.050	99.852	99.906	99.913	99.948	99.999
4	0.075	99.884	99.924	99.956	99.985	100.002
5	0.100	99.831	99.871	99.691	99.926	99.941
6	0.125	99.803	99.830	99.861	99.986	99.905
7	0.150	99.744	99.764	99.797	99.824	99.854
8	0.175	100.740	100.761	100.782	100.803	100.831
9	0.200	100.810	100.853	100.851	100.866	100.888
10	0.225	100.879	100.923	100.945	99.969	100.979
11	0.250	101.086	101.174	101.193	101.220	101.239
12	0.275	101.059	101.095	101.110	101.127	101.134
13	0.300	101.015	101.054	101.075	101.104	101.114
14	0.325	101.109	101.154	101.182	101.203	101.223
15	0.350	101.167	101.207	101.236	101.266	101.283
16	0.375	101.102	101.199	101.242	101.271	101.306
17	0.400	101.150	101.210	101.236	101.250	101.272
18	0.425	101.165	101.192	101.208	101.236	101.248
19	0.450	101.294	101.306	101.335	101.344	101.350
20	0.475	101.312	101.220	101.215	101.317	101.315
21	0.500	101.285	101.277	101.277	101.273	101.270
22	0.525	101.336	101.333	101.339	101.342	101.343
23	0.550	100.766	101.267	101.269	101.281	101.292
24	0.575	101.238	101.249	101.262	101.268	101.272
25	0.600	101.127	101.128	101.127	101.132	101.131
26	0.625	101.137	101.141	101.144	101.147	101.142
27	0.650	101.148	101.148	101.145	101.142	101.135
28	0.675	101.160	101.158	101.157	101.154	101.157
29	0.700	101.186	101.178	101.181	101.185	101.184
30	0.725	101.193	101.180	101.179	101.178	101.177

TRAFFIC MEASUREMENT PROCEDURES

The data required by a traffic engineer can mainly be observed on field rather than at laboratory. Now the field studies can be classified into three types depending upon the length of observation:

- Measurement at a point
- Measurement over a short section
- Measurement over a long section

Name of road: Lucknow-Deva road **Traffic Direction**: Both
Location: Shri Ramswaroop Memorial University **Date:** 01/02/2018

Time period	PassengerVehicle				GoodVehicle			
from-to	Two Vehicle	Auto Rickshaw	Car	MiniBus/ Bus	LCV	2 Axle	3 Axle	MAV
8-9	27	11	29	15	23	11	9	2
9-10	36	18	34	18	29	15	7	1
10-11	45	20	25	13	22	17	4	1
11-12	41	15	27	8	37	15	6	2
12-13	52	13	37	14	29	26	8	0
13-14	31	8	28	7	28	27	5	2
14-15	39	19	40	9	37	25	7	1
15-16	16	17	33	11	29	22	11	2
16-17	56	16	27	17	21	21	17	5
17-18	38	11	36	13	15	17	15	1
18-19	25	7	31	6	21	12	19	5
19-20	32	5	40	2	17	22	21	0
20-21	24	3	33	0	23	16	15	3
21-22	27	1	46	3	15	25	17	2
22-23	19	0	31	0	10	22	16	1
23-00	21	1	27	0	4	32	0	4
00-1	15	0	25	0	5	36	2	0
1-2	17	0	21	0	0	22	5	2
2-3	11	0	22	0	0	19	8	1
3-4	13	0	17	0	4	21	11	0
4-5	16	0	25	2	0	24	12	8
5-6	25	3	29	4	4	34	19	4
6-7	28	6	32	8	8	20	28	2
7-8	33	9	37	11	15	12	20	0

Trafficcensus(day1)
Name of road: Lucknow-Deva road **Traffic Direction**: Both
Location: Shri Ramswaroop Memorial University **Date:** 02/02/2018

Time period	PassengerVehicle				GoodVehicle			
from-to	Two Vehicle	Auto Rickshaw	Car	MiniBus/ Bus	LCV	2 Axle	3Axle	MAV
8-9	27	11	29	15	26	12	8	2
9-10	26	18	34	18	29	11	4	0
10-11	36	20	25	11	25	16	5	1
11-12	45	15	27	7	35	19	5	1
12-13	41	13	37	13	29	19	8	0
13-14	52	8	28	6	25	25	6	2
14-15	31	19	40	9	35	26	7	1
15-16	39	17	33	15	27	18	9	0
16-17	42	16	27	6	19	17	8	6
17-18	56	11	30	8	16	22	11	1
18-19	38	7	31	0	19	29	6	0
19-20	25	5	40	0	4	27	9	2
20-21	32	3	33	3	5	19	0	4
21-22	34	1	46	1	6	30	2	3
22-23	27	0	31	0	2	25	1	2
23-00	19	1	27	2	0	20	10	1
00-1	21	0	25	1	1	19	15	0
1-2	15	0	21	1	1	21	18	1
2-3	11	0	22	0	0	18	19	2
3-4	13	0	17	5	3	15	19	2
4-5	16	0	25	4	5	8	21	3
5-6	25	3	29	6	7	5	9	2
6-7	28	6	32	7	9	7	7	1
7-8	33	9	36	9	11	11	3	0

Traffic census(day2)

SUBGRADE SOIL

TESTS ON SOIL

- Shear tests
- Bearing tests
- Penetration tests
- California Bearing Ratio test

- Plate Bearing Test
- Optimum moisture content
- Liquid limit
- Plastic limit
- **PROCTOR TEST**
- Weight of soil =2500gm
- Weight of mould=2158gm
- Volume of mould=997cc

S.NO	WATER(cc)	SOIL+MOULD(gm)	MOISTURE%	WET DENSITY(g/cc)	DRY DENSITY (g/c)
1.	250	4071	7.9	1.91	1.75
2.	300	4130	9.0	1.97	1.79
3.	350	4184	10.1	2.03	1.81
4.	400	4251	1187	2.09	1.85
5.	450	4142	14.47	1.98	1.69

S.NO						
1.	CONTAINER NO.	251	184	203	171	143
2.	WT OF WET SOIL CONTAINER (gm)	62.44	73.35	72	64.75	67.69
3.	WT OF DRY SOIL CONTAINER (gm)	59.55	69.05	67.53	60.44	61.96
4.	WT OF CONTAINER (gm)	26.17	25.70	27.60	26.51	28.05
5.	WT OF MOISTURE (gm)	2.96	4.22	4.64	4.31	5.73
6.	WT OF DRY SOIL (gm)	53.4	43.4	39.93	33.93	33.91
7.	MOISTURE%	7.9	9.0	10.1	11.21	14.67

RESULT*-The maximum dry density (1.963g/cc) of subgrade soil acheived at water content 13.18%*

Hence, OMC=13.81%

Atterberg's Limits

TYPE OF TEST	LIQUID LIMIT			PLASTIC LIMIT		
OBSERVATIONS						
NO OF BLOWS	30	27	22			
CONTAINER NO.	104	109	200			
WT OF WET SOIL+CONTAINER(GMS)	27.29	21.39	23.25			
WT OF DRY SOIL+CONTAINER(GMS)	25.35	20.44	22.19	NON PLASTIC		
WT OF CONTAINER	16.75	16.35	17.84			
WT OF MOISTURE (GM)	1.94	0.95	1.06			
WT OF DRY SOIL (GM)	8.6	4.09	4.35			
MOISTURE CONTENT%	22.55	23.22	28.7			
LL,PL,PI	26.0,NON PLASTIC			16.0		

RESULT*: Hence liquid limit of above soil is 26% which shows that beyond 26% moisturecontent the soil tends to behave like liquid nature.*

FORMATION LEVEL OF SUBGRADE LANE -1

		LEFT		CENTRE		RIGHT
S.NO.	CHAINAGE	C1-1.75	C1-1	C1	C1-1	C1-1.75
1	0.000	99.683	99.705	99.735	99.765	99.787
2	0.100	99.883	99.905	99.935	99.965	99.987
3	0.200	100.083	100.105	100.135	100.165	100.187
4	0.300	100.283	100.305	100.335	100.365	100.387
5	0.400	100.483	100.505	100.535	100.565	100.587
6	0.500	100.683	100.705	100.735	100.765	100.787
7	0.600	100.883	100.905	100.935	100.965	100.987
8	0.700	101.083	101.105	101.135	101.165	101.187
9	0.800	101.283	101.305	101.335	101.365	101.387
10	0.900	101.483	101.505	101.535	101.565	101.587
11	1.000	101.683	101.705	101.735	101.765	101.787

FORMATION LEVEL OF SUBGRADE LANE -4

		LEFT		CENTRE	RIGHT	
S.NO.	CHAINAGE	C4-1.75	C4-1	C4	C4-1	C4-1.75
1	0.000	99.683	99.705	99.735	99.765	99.787
2	0.100	99.883	99.905	99.935	99.965	99.987
3	0.200	100.083	100.105	100.135	100.165	100.187
4	0.300	100.283	100.305	100.335	100.365	100.387
5	0.400	100.483	100.505	100.535	100.565	100.587
6	0.500	100.683	100.705	100.735	100.765	100.787
7	0.600	100.883	100.905	100.935	100.965	100.987
8	0.700	101.083	101.105	101.135	101.165	101.187
9	0.800	101.283	101.305	101.335	101.365	101.387
10	0.900	101.483	101.505	101.535	101.565	101.587
11	1.000	101.683	101.705	101.735	101.765	101.787

EARTHWORK AMOUNT

S.NO	DESCRIPTION	QUANTITY(m^3)	RATE	AMOUNT(Rs.)
1	Earthwork in embankment LANE 1	488.3129	95	46389.7255
2	Earthwork in excavation LANE 1	1580.5065	125	197563.3125
3	Earthwork in embankment LANE 4	717.0358	95	68118.401
4	Earthwork in excavation LANE 4	1458.4324	125	182304.05
TOTAL				494375.489

FORMATION LEVEL OF GRANULAR SUB BASE (GSB) LANE-1

		LEFT		CENTRE	RIGHT	
S.NO.	CHAINAGE	C1-1.75	C1-1	C1	C1-1	C1-1.75
1	0.000	99.883	99.905	99.935	99.965	99.987
2	0.100	100.083	100.105	100.135	100.165	100.187
3	0.200	100.283	100.305	100.335	100.365	100.387
4	0.300	100.483	100.505	100.535	100.565	100.587
5	0.400	100.683	100.705	100.735	100.765	100.787
6	0.500	100.883	100.905	100.935	100.965	100.987
7	0.600	101.083	101.105	101.135	101.165	101.187
8	0.700	101.283	101.305	101.335	101.365	101.387
9	0.800	101.483	101.505	101.535	101.565	101.587
10	0.900	101.683	101.705	101.735	101.765	101.787
11	1.000	101.883	101.905	101.935	101.965	101.987

FORMATION LEVEL OF GRANULAR SUB BASE (GSB) LANE-4

		LEFT		CENTRE	RIGHT	
S.NO.	CHAINAGE	C4-1.75	C4-1	C4	C4-1	C4-1.75
1	0.000	99.883	99.905	99.935	99.965	99.987
2	0.100	100.083	100.105	100.135	100.165	100.187
3	0.200	100.283	100.305	100.335	100.365	100.387
4	0.300	100.483	100.505	100.535	100.565	100.587
5	0.400	100.683	100.705	100.735	100.765	100.787
6	0.500	100.883	100.905	100.935	100.965	100.987
7	0.600	101.083	101.105	101.135	101.165	101.187
8	0.700	101.283	101.305	101.335	101.365	101.387
9	0.800	101.483	101.505	101.535	101.565	101.587
10	0.900	101.683	101.705	101.735	101.765	101.787
11	1.000	101.883	101.905	101.935	101.965	101.987

WET MIX MACADAM SUB BASE

Physical requirement of coarse aggregates for WMM

s. no.	TEST	TEST METHOD	REQUIREMENTS
1	LOS ANGELES ABRASION VALUE OR	IS:2386(PART IV)	40%(MAX)
	AGGRGATE IMPACT VALUE	IS :2386(PART IV) OR IS:5640	30%
2	COMBINED FLAKINESS IS:2386(PART I) 35% AND ELONGATION		

Grading requirement of aggregates for WMM

IS SIEVE	53mm	45mm	22.4mm	11.20mm	4.75mm	2.36mm	600micron	75micron
PERCENT WEIGHT PASSING SEIVE	100	95-100	60-80	40-60	25-40	15-30	6-18	4-8

FORMATION LEVEL OF WATER MIX MACADAM (WMM) LANE-1

		LEFT		CENTRE	RIGHT	
S.NO.	**CHAINAGE**	**C1-1.75**	**C1-1**	**C1**	**C1-1**	**C1-1.75**
1	0.000	100.083	100.105	100.135	100.165	100.187
2	0.100	100.283	100.305	100.335	100.365	100.387
3	0.200	100.483	100.505	100.535	100.565	100.587
4	0.300	100.683	100.705	100.735	100.765	100.787
5	0.400	100.883	100.905	100.935	100.965	100.987
6	0.500	101.083	101.105	101.135	101.165	101.187
7	0.600	101.283	101.305	101.335	101.365	101.387
8	0.700	101.483	101.505	101.535	101.565	101.587
9	0.800	101.683	101.705	101.735	101.765	101.787
10	0.900	101.883	101.905	101.935	101.965	101.987
11	1.000	102.083	102.105	102.135	102.165	102.187

III RESULT

DESIGN OF RIGID PAVEMENT FROM MATI TO SHRI RAMSWAROOP MEMORIAL UNIVERSITY

- **Data given:**

- Present traffic- 1786 commercial vehicle /day (CVPD)
- Elastic modulus of concrete – 3×10^5 kg/cm^2

- Poisson's ratio – 0.15
- Coefficient of thermal expansion of concrete – 10×10^{-6}/ °C Design life – 20 years
- Concrete grade**-** M40 N/mm^2
- Dry lean concrete sub base – 15cm = 150mm DLC must be laid before castingC.C slab
- Types of cement to be used – OPC 43 grade
- Rate of traffic increase – 0.075
- CBR (soaked) of sub grade **-** 5%
- Tyre pressure – 8 kg/cm^2
- Modulus of sub grade reaction k, for above CBR **-** 4.2 $kg/cm^2/cm$
- Effective k over 150mm treated sub base as per table 4 for above k= sub grade reaction = 20.8 $kg/cm^2/cm$
- Load safety factor being ODR – 1.2

DESIGN

- Present traffic- 1786 commercial vehicle /day (CVPD)
- Design life – 20 years
- Rate of traffic increase – 0.075
- Cumulative number of axle during the design period $=\frac{\{365A(1+r)^n-1\}}{r}$**=28229888.72 commercial vehicles**

DESIGN TRAFFIC

- =25% of the total repetition of commercial vehicles
- =0.25 × 28229888.72 **= 7057472.18 = 7.06 million standard axle (MSA)**

- **Following design is based on above MSA commercial vehicles**
- **Characteristic strength of given concrete grade M40**

- $f_{cr}=0.7\sqrt{40}$, $f_{cr}=44.3 kg/cm^2$

- **According to CRONEY and CRONEY (Appendix - 5 of IRC 58:2002)**

- **$f_{cr} = 0.36\times f_{ck}^{0.7}$ (for crushed aggregates) Load safety factor = 1.2**

$= 0.36\times40^{0.7} = 47.6\ kg/cm^2$

$$Average\ f_{cr} = (44 + 47.6)/2$$

$=45.95\ kg/cm^2$

- **Finally $f_{cr} = 1.2\times45.95 = 55.14\ kg/cm^2 \cong 55\ kg/cm2$**

- ***Calculation For Modulus Of Sub Grade (K) Based On Page -10, IRC 58:2002, (Table-2)*** *At GIVEN* ***CBR = 5%K = 4.2 kg/cm²/cm***

NOTE: 150mm DLC must be laid before casting C.C slab.

Effective (k) = 20.8 $kg/cm^2/cm$ **{Page – 11 table-4 IRC 58:2002}**

IN ABSENCE OF AXLE LOAD DISTRIBUTION:-

Assuming distribution of CVPD as 70% CPVD are single axle and carrying load of 13.15 tons (say 14 tons) and remaining 30% are tandem axle carrying load of (20-24) tons (say 22 tons)
Total repetitions = 7057472.18 M.S.A
Assuming thickness of C.C slabs =28 cm

L.S.F = 1.2

Single Axle Loads			Tandem Axle Loads		
Axle Load Class Tons	% of Design Axle loads	M.S.A.	Axle loads Class Tons	% of Design Axle loads	M.S.A.
14	70	4940230.526	22	30	2117241.654

Trial thickness = 28cm
Effective (k) = 20.8 kg/cm^2/cm
Load safety factor = 1

Axle Loads (AL) Tones	AL×L.S.F	Flexural Stress due to load from Charts	Stress Ratio	Expected Repetitions as per M.S.A	Allowable repetitions, Fatigue Life(N) based on stress ratio	Fatigue Life Consumed Ratio
(1)	(2)	(3)	(4)	(5)	(6)	(5/6)
Single Axle						
14	16.8	20	0.364	4940230.526	∞	0
TandemAxle						
22	26.4	13	0.236	2117241.654	∞	0

IV CONCLUSION

1. The construction of rigid pavement would overcome the problem of heavy load traffic carriage which flexible pavement is unable to bear.
2. The redesigning of the pavement would certainly lead to management of traffic load hence minimizing traffic jams.
3. The Life Period Of Rigid Pavement is much higher than flexible therby lessening the cost of reconstruction.
4. Rigid pavement can bear higher temperature variations which lessens the maintenance costs of pavement.
5. Pavement maintenance costs is ten times lesser in rigid pavements.

V REFERENCES

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2. IRC:SP:49-2014 GUIDELINES FOR THE USE OF DRY LEAN CONCRETE AS A
3. SUB BASE FOR RIGID PAVEMENT
4. IRC:58-2002 GUIDELINES FOR THE DESIGN OF PLAIN JOINTED RIGID
5. PAVEMENT FOR HIGHWAYS
6. IRC:9-1972 TRAFFIC CENSUS ON NON URBAN ROADS
7. IRC:SP:19-2001 MANNUAL FOR SURVEY , INVESTIGATION AND PREPRATION
8. OF ROAD PROJECTS
9. IS 10262 (2009) : GUIDELINES FOR CONCRETE MIX DESIGN PROPORTIONING
10. IRC:109-2015 GUIDELINES FOR WET MIX MACADAM