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Design and Estimate of Rigid Pavement for National Highway Using IRC 58

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Abstract- **Pavement design plays vital role in the Road projects. The suitable performance of the pavement will end result in more savings with respect to operating costs of vehicle and traveling time. This paper confers about the rigid pavement design using IRC 58 that are being monitors and inspects "Design and estimate of rigid pavement by IRC methods & their material testing by various testing method"**

Index terms- **Design of Rigid Pavement, Material Testing, IRC, Heavy Traffic**

I.INTRODUCTION

The road transportation is the only way which gives maximum facility to one and all. This way of transportation has the most elasticity for travel with orientation to direction, route, time and travel speed. It is probable to provide door to door facility only by road transport. Rigid pavement a more advantages such as longer life span, minor maintenance, user friendly and Eco friendly and lesser cost. Keeping in this sight, the whole life cycle cost analysis for the Rigid Pavement have been done based on different conditions such as types of lane (single lane, two lane, four lane), dissimilar traffic categories, deterioration of road.

Pavement is a structure containing of superimposed coatings of various materials above the sub-grade, whose main function is to allot the applied vehicle loads to the sub-grade. The pavement structure should be capable of providing a surface of tolerable riding quality, acceptable skid resistance, constructive light reflecting characteristics, and less noise pollution. The eventual purpose is to confirm that the transmitted stresses as a result of wheel load are satisfactorily reduced, so that they will not surpass bearing capacity of the natural sub- grade.

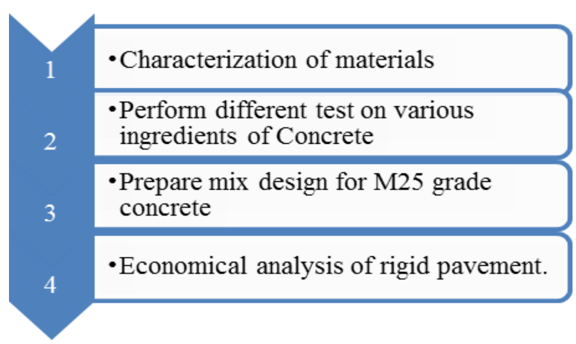
The main objective of this study is to design a rigid pavement for a National Highway 166 (Ratnagiri-Kolhapur) for regular traffic conditions. The secondary objective of this study deals with material characteristics of different materials used for concrete production of grade M25.

II. OBJECTIVES OF THE PRESENT WORK

Objectives of the Research work are given as follows:

- To perform characterization of materials present in concrete.
- To perform different test on various ingredients of Concrete.
- To prepare mix design for M25 grade concrete.
- To perform economic analysis of rigid pavement

III. METHODOLOGY



IV. CHARACTERIZATION OF MATERIALS

CEMENT

Ordinary Portland cement of 53 Grade obtainable in local market is used in the research. The cement used has been tested for various properties according to IS: 4031-1988 and found to be approving to various specifications of IS: 12269-1987 having specific gravity of 3.15.

AGGREGATES

FINE AGGREGATE-

Locally available well-graded, clean, natural river sand (or M- Sand) having fineness modulus of 2.6 following to IS 383-1970 was used as fine aggregate.

COARSE AGGREGATE-

Crushed angular granite aggregate of size 20 mm obtained from local market with specific gravity of 2.60 was used.

WATER

Potable locally available water following to IS 456 is used.

V. DIFFERENT TEST ON VARIOUS INGREDIENTS OF CONCRETE

A) Test on Cement:

1. Fineness Test:

Weight of Sample (gms)	Weight of Residue (gms)	% Residue
100	2	2%
100	4	4%

2. Setting Time:

1. % Water required for Standard Consistency = 30%
2. % Water taken for Test = 0.85 x 30% = 25.5 %

Sr. No.	Weight of Cement (gms)	Weight of Water (gms)	Initial Setting time (Min.)	Final Setting Time (Min.)
1	400	25.5 x 400 = 102	32	345

B) Test on coarse aggregate:

Crushed angular aggregate of size 20 mm size from local source.

1. Fineness modulus of coarse aggregate

Observation Table

Sr. No.	IS Sieve No.(mm)	Residue(gms)	Cumulative residue (gms)	% Residue	% Cumulative Residue
1.	100	0	0	0	0
2.	80	0	0	0	0
3.	63	0	0	0	0
4.	40	0	0	0	0
5.	25	150	150	15	15
6.	20	570	720	57	72
7.	12.5	280	1000	28	100
8.	4.75	0	1000	0	100

Calculation:

$$\text{Fineness Modulus} = \frac{\Sigma\% \text{ Cumulative residue}}{100}$$

$$\text{Fineness Modulus} = \frac{287}{100}$$

$$\text{Fineness Modulus} = 2.87$$

2. Flakiness Index & Elongation Index:

Weight of sample= 5794 gms

Observation Table

Sr. No.	Sieve Size	Thickness Gauge size (mm)	Weight passing thickness gauge (gms)	Length of Gauge size (mm)	Weight retained on Length gauge (gms)
1.	40	27	0	81	0
2.	25	16.95	0	58	0
3.	20	13.5	235	40.5	154
4.	16	10.8	216	32.4	135
5.	12.5	8.55	135	25.5	195
6.	10	6.75	169	20.2	142
7.	6	4.89	63	14.7	69
Total			818		695

Calculation:

$$\text{Elongation index} = \frac{\text{Weight retained on Length guage}}{\text{Total weight on aggregate}}$$

$$\text{Elongation index} = \frac{695}{5794} * 100$$

Elongation index= 11.99 %

$$\text{Flakiness index} = \frac{\text{Weight Passing thickness guage}}{\text{Total weight of aggregate}} * 100$$

$$\text{Flakiness index} = \frac{818}{5794} * 100$$

Flakiness index =14.12%

Combined Elongation and Flakiness index = 26.11%

Maximum allowable Combined Elongation and Flakiness index for Concrete is 30%.

4. Specific Gravity:

Observation Table

Sr. No.	Particulars	Weight (gms)
1	Weight of Pycnometer (M1)	669
2	Weight of Pycnometer filled with Aggregate (M2)	1158
3	Weight of Pycnometer + Aggregate + Water (M3)	1670
4	Weight of Pycnometer filled with Water (M4)	1351

Calculation:

Specific Gravity = $\frac{(M2-M1)}{(M4-M1)-(M3-M2)}$

Specific Gravity = $\frac{(1158-669)}{(1351-669)-(1670-1158)}$

Specific Gravity = 2.87

5. Water Absorption Test:
1. Weight of saturated surface dry aggregate (W1) = 460 gms
2. Weight of oven dry aggregate (W2) = 451 gms

Water Absorption = $((W_1 – W_2) / W_2)$ X 100
Water Absorption = ((460 – 451) / 460) X 100
Water Absorption =1.96 %

6. Abrasion value:
Weight of saturated surface - dry sample (W_1) = 1000 gms
Weight of fraction passing through 1.70 mm IS Sieve (W_2) = 158 gms

Aggregate Abrasion Value = $\frac{W2}{W1} * 100$

Aggregate Abrasion Value = $\frac{158}{1000} * 100$

Aggregate Abrasion Value = 15.8 %

7. Impact value:
Weight of saturated surface - dry sample (W_1) = 1000 gms
Weight of fraction passing through 2.36 mm IS Sieve (W_2) = 382 gms

Aggregate Impact Value = $\frac{W2}{W1} * 100$

Aggregate Impact Value = $\frac{382}{1000} * 100$

Aggregate Impact Value = 38.2 %

8. Crushing value:
Weight of saturated surface - dry sample (W_1) = 1000 gms
Weight of fraction passing through 2.36 mm IS Sieve (W_2) = 382 gms

Aggregate Crushing Value = $\frac{W2}{W1} * 100$

Aggregate Crushing Value = $\frac{382}{1000} * 100$

Aggregate Crushing Value = 38.2 %

C) Test on fine aggregate:
Locally available well-graded, clean, natural river sand.

1. Fineness modulus of fine aggregate
Observation Table

Sr. No.	IS Sieve No. (mm)	Residue (gms)	Cumulative residue (gms)	% Cumulative Residue
1.	25	0	0	0
2.	10	0	0	0
3.	4.75	43	43	4.3
4.	2.36	92	135	13.5
5.	1.18	246	381	38.1
6.	600 µ	325	706	70.6
7.	300 µ	246	952	95.2
8.	150 µ	41	993	99.3

Calculation:

$$\text{Fineness Modulus} = \frac{\Sigma\% \text{ Cumulative residue}}{100}$$

$$\text{Fineness Modulus} = \frac{321}{100}$$

Fineness modulus= 3.21

3. Specific Gravity:
Observation Table

Sr. No.	Particulars	Weight (gms)
1	Weight of Pycnometer (M1)	669
2	Weight of Pycnometer filled with Aggregate (M2)	1120
3	Weight of Pycnometer + Aggregate + Water (M3)	1794
4	Weight of Pycnometer filled with Water (M4)	1481

Calculation:

Specific Gravity = $\frac{(M2-M1)}{(M4-M1)-(M3-M2)}$

Specific Gravity = $\frac{(1120-669)}{(1481-669)-(1794-1158)}$

Specific Gravity = 2.56

3. Water Absorption Test:
1. Weight of saturated surface dry aggregate in air (W3) = 501 gms
2. Weight of oven dry aggregate (W4) = 489 gms

Water Absorption = $((W_3 – W_4) / W_4)$ X 100
Water Absorption = ((501 – 489) / 489) X 100
Water Absorption = 2.25 %

WATER
Locally available potable water conforming to IS 456-2000 is used.

VI. MIX DESIGN OF M25 CONCRETE

CEMENT	FA	CA	Water
435.409	631.194	1215.273	203.430
1	1.45	2.79	0.467

VII. ECONOMIC ANALYSIS OF RIGID PAVEMENT

MATERIAL	QUANTITY (kg)	RATE (per kg)	FINAL AMOUNT(Rs.)
Cement	23141	248.46 per bag	57,49,612.86/-
Sand	1174.35	1575 per m^3	18,49,601.25/-
Aggregate	2259.68	809.22 per m^3	18,28,578.25/-
Steel	65940	43.543 per kg	28,71,225.42/-
Binding Wire	462	63.26 per kg	29,226.12/-
Total			1,23,28,244/

Rigid Pavement requires: 1.23 Crores per Km

VIII. CONCLUSIONS

- Material characterization is as per IS Provisions.
- Mix Proportion for M25 Concrete is 1:1.45:2.79.
- Per Km cost of Rigid Pavement comes out to be 1.23 Crore.

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