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QUALITY ASSURANCE AND BITUMINOUS MIX DESIGN FOR CHENNAI OUTER RING ROAD.

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Abstract - *The main aim of this project is to measure the quality assurance for construction of **flexible pavement Chennai outer ring road**. In order to achieve the aim of building safe, serviceable, durable and economic highways, the road structure should meet certain requirements. The characteristics that a structure should possess to fulfil these requirements have to specified. The codes of practice and the contract documents strive to achieve this by way of defining criteria, practical rules, technical specifications, testing and acceptance criteria and workmanship. All these strategies implicitly depend upon human skills for their successful and reliable application which, eventually, determines the quality of highways. The basic desire to produce quality work is essential in the minds of all those connected with highways projects. The guide lines have, therefore, been evolved to facilitate preparation of appropriate quality system for individual highway projects. Indian Economy is based on the infrastructure of the country. Highway and pavement design plays an important role in the DPR projects. Regarding the pavement design, it forms an important part of detailed engineering study. The satisfactory performance of the pavement will result in higher savings in terms of vehicle operating costs and travel time, which has a bearing on the overall economic feasibility of the project. This project discusses about the design methods that are traditionally being followed and examines the relative merits of flexible pavement.*

1. INTRODUCTION

This report presents the quality assurance and quality control for road project. The quality assurance and quality control of materials like concrete, coarse aggregate, fine aggregate and bituminous are tested with various apparatus like aggregate impact value test, proctor test, flakiness and elongation test, direct shear test, bituminous extraction test, bituminous penetration and softening test, Marshall Stability test etc. Quality Assurance is the process of identifying or deciding all the quality requirements for a project, identifying existing quality documents such as codes, specifications etc. The procedure for bituminous mix design is done after the quality assurance is completed.

Phase-I

- Segment-I: NH-45 to NH-4 (Ch. Km. 0+000 to Km. 18+950)
- Segment-II: NH-4 to NH-205 (Ch. Km. 18+950 to Km. 29+650)

Phase-II

- Segment-Ill: NH-205 to NH-5 (Ch. Km. 29+650 to Km. 47+590)
- Segment-IV: NH-5 to TPP Road (Ch. Km. 47+590 to Km. 62+300)

The section of ORR connecting NH-205 near Nemilicheri village to TPP Road at Minjur(Phase-I)has been awarded to GVR Ashoka Chennai ORR Limited on DBFOT Annuity basisGVR Ashoka Chennai ORR Limited has appointed ASC InfratechPvt Ltd. as Detailed Engineering Design Consultant for ORR Phase-II. In this regard, consultant have carried out the traffic assessment study for the corridor and the details are provided in this report.

1.1.2 NEED OF OUTER RING ROAD (ORR)

The **Chennai Metropolitan Area(CMA)** is the fourth largest metropolitan area in India. The CMA consists of the metropolitan city of Chennai and its suburbs such as Kanchipuram andTiruvallur district respectively. CMA area encompassing 1189 sq. km around the city and the **Chennai Metropolitan Development Authority (CMDA)** has been designated as the authority to plan the growth of the city and the area around it.Chennai city has four major arterial roads i.e. **NH- 5, NH-205, NH-4, and NH-45** which connects Chennai port and other industrial areas in CMA area**.** Two ring roads are existing for connecting these radial roads namely,

- **Inner Ring Road (IRR)- six lane divided carriageway.**

Chennai Bypass(Phase-1&2) NHAI - access controlled six lane divided carriageway The exceptionally heavy traffic on the major arterial road and radial roads of Chennai city leadsto frequent traffic congestions resulting in longer traveling time and wastage of fuel.In order to relieving the congested heavy traffic on the major arterial roads within the city andalso for catalysing the even dispersal of urban

growth ,as a part of its Master Plan has proposedthe development of Outer Ring Road (ORR) along the periphery of Chennai Metropolitan Area(CMA).

1.2 DESIGN METHODOLOGY

The pavement design is based on various design parameters, design procedures, calculations and to cover all the requirements of the pavement for the project road, designs have been prepared for,

- Flexible pavement design for main carriageway,
- Flexible pavement design for Service Road/Junction,/Truck Lay Bye/Bus bay

The Flexible pavement design methodology is generally based on the guidelines of "**Manual of Specification for 6 laning of Highways through Pubic Private Partnership and IRC: 37-2012"**

2. EXPERIMENTAL INVESTIGATION

Materials needed for quality assurance and bituminous mix design are Bituminous, Concrete, Cement, Soil, Coarse Aggregate, Fine Aggregates, and water.

2.1 TESTS

CBR test: Proving ring factor 1 Div. = 6.191 kgs Fineness by dry sieving = 2.78% Consistency Initial and Final Setting Time of Cement

Compressive strength of cement

Gradation for GSB material

Atterberg limits =LL-29.3 PL-20.1 PI-9.2

Sieve Analysis for Fine Aggregates

Free swell index = 10%

Modified Proctor compaction Test

Flakiness and Elongation Test

Viscosity Test

Softening point test

Penetration test

Source of Materials:

3. BITUMINOUS MIX DESIGN

Bituminous mix design is a delicate balancing act among the proportions of various aggregate sizes and bitumen content. For a given aggregate gradation, the optimum bitumen content is estimated by satisfying number of mix design parameters. The design of bituminous mixes for BM, DBM, BC is checked out.

OBJECTIVES OF MIX DESIGN

- The objective of the mix design is to produce a bituminous mix by proportionating various components so as to have: sufficient bitumen to ensure a durable pavement,
- sufficient strength to resist shear deformation under traffic at higher temperature,
- sufficient air voids in the compacted bitumen to allow for additional compaction by traffic,
- sufficient workability to permit easy placement without segregation,
- sufficient flexibility at low temperature to prevent shrinkage cracks

CONSTITUENTS OF A MIX

- **Coarse aggregates:** Offer compressive and shear strength and shows good interlocking properties. E.g. Granite
- **Fine aggregates:** Fills the voids in the coarse aggregate and stiffens the binder. E.g. Sand, Rock dust
- **Filler:** Fills the voids, stiffens the binder and offers permeability. E.g. Rock dust, cement, lime
- **Binder:** Fills the voids, cause particle adhesion and gluing and offers impermeability. E.g. Bitumen, Asphalt, Tar

1. Aggregate	Nelavoyal Crusher IOCL, Chennai
2. Bitumen VG-40	

Summary of BC (Grading-II)

PROPORTIONS OF THE AGGREGATE (HOT BIN AGGREGATES)

1. 14 mm - 6 mm	:	42%
2. 6 mm – 0 mm	:	58%

Parameter of Mix:

1. Binder Content	:	5.1%
2. Voids in mix (Air Voids)	:	4.3%
3. Voids Filled with Bitumen (VFB)	:	70.3%
4. Voids in Mineral Aggregate (VMA)	:	14.3%
5. Marshall Stability	:	1653 kg
6. Flow	:	3.6 mm
7. Marshall Quotient	:	459
8. Filler to Binder Ratio	:	1.15
9. Max. Theoretical Density (Gmm)	:	2.488
10. Bulk Density (Gmb)	:	2.382
11. Gsa	:	2.703
12. Gsb	:	2.639 2.684
13. Gse	:	

A.SPECIFIC GRAVITY OF AGGREGRATES

Sl. No	Description	Bulk Spec. Gravities	Apparent Spec. Gravities	Remarks
1.	14-6mm	2.665	2.699	
2.	6-0mm	2.620	2.707	

S.No	Description of Test	Required as per Specification	Result	Remarks
1	Specific Gravity at 27^{0}C IS:1202-1978,	Min.0.99	1.055	Satisfactory
2	Penetration at 25^{0}C IS:1203-1978	Min.35	43	Satisfactory
3	Softening Point IS:1205-1978	Min. 50	53.7	Satisfactory
4	Ductility at 25 0 C	Min.25cm	58	Satisfactory
5	Absolute Viscosity at 60 0 C,Poises	3200-4800	3573	Satisfactory
6	Kinematic Viscosity at 135 0 C cST	Min.400	470	Satisfactory
7	Flash Point deg C	Min.220	292	Satisfactory

PROPOSED AGGREGATES FOR BC (GRADING-II):

The selected aggregates for Bituminous Concrete design are as follows:

1. **14mm - 6mm : 42%**
2. **6mm - 0mm : 58%**

Each compacted specimen is subjected to the following tests and analyzed in order listed below

a. Bulk Density Determination

b. Stability and Flow Test

c. Density and Voids analysis.

Using the Bulk density of the aggregates and maximum Specific Gravity of Bituminous

Paving mix, % of air voids, %of air voids in mineral aggregates and voids filled with bitumen are calculated.

Separate graphical plot for the following values are illustrated in figures enclosed.

a. Stability Vs. Bitumen content
b. Bulk Density vs. Bitumen content
c. Flow Vs. Bitumen content
d. Air voids Vs. Bitumen Content
e. Voids in Mineral Aggregates (VMA) Vs. Bitumen content.
f. Voids Filled with Bitumen (VFB) Vs. Bitumen Content.

REQUIREMENTS OF BC (GRADING-II) MIX:

Apart from conformity with grading and Quality requirements of individual ingredients, the mix will meet the requirements given in Table 500.17&18 of MORT&H, IRC-111(2009).

MARSHALL TEST RESULTS

Bitumen content %	Density g/cc	Air voids (%)	VMA (%)	VFB (%)	Stability (in Kn)	Flow in mm
4.50	2.355	6.17	14.75	58.39	1872	3.0
4.75	2.383	4.71	13.97	66.26	1993	3.2
5.00	2.409	3.33	13.26	74.92	2116	3.7
5.25	2.414	2.77	13.30	79.16	2081	3.7
5.50	2.414	2.40	13.51	82.21	1977	4.2

CONFORMATION MARSHALL TEST FOR BC Grading-II MIX

Date of casting - 08/02/2017 Location - GVR QA/QC lab No Of Blows – 75+75 Both sides
Date of testing - 09/02/2017 Bitumen Grade -VG-40 (IOCL)
Kind of material - BC Grading-II Design Mix Specific Gravity Of Bitumen - 1.055 Effective specific gravity- 2.684
Bulk Sp Gr. of Total Agg. (Gsb) – 2.639 Proving ring coraction factor - 6.191

Sample No	Agg. % by total weight	Bitumen % By Total Weight	Max. SP. GR. of Mix	Mass of specimen in gms.			Thickness of specimen	Stability correction Ratio	Bulk vol. (cc)	Bulk Density of Compacted Mix	% Air Voids (3-6) 3 x 100	% V M A 100-[6X1)/Gsb]	% V F B (8-7)/8 X 100	Stability Kgs.		Flow (mm)
				In Air	In Water	SSD								load	Stability	
	1	2	3	4					5	6	7	8	9	10	11	12.00
1				1241	725	1245	64.8	1.00	520	2.387				278	1721	3.50
2				1253	730	1255	64.2	0.96	525	2.387				280	1664	3.90
3				1245	724	1248	64.9	0.96	524	2.376				265	1575	3.50
4				1256	730	1258	64.2	0.96	528	2.379				For Retained Stability		
5				1242	724	1244	64.3	1.00	520	2.388						
6				1248	725	1250	64.6	0.96	525	2.377						
Average	94.9	5.10	2.488				64.5			2.382	4.3	14.3	70.3		1651	3.6

5. RESULTS AND DISCUSSION:

This study indicates the quality assurance of materials for coarse aggregates, fine aggregates, soil, cement, concrete and bituminous mix design is checked out. To find the quality of materials various tests are carried out to find out the percentage difference. The significant conclusions arrived at after carrying out the laboratory tests .In laboratory tests, the results mentioned in the previous chapter that the quality assurance for materials is reached up to the satisfaction as per IS specifications. Marshal stability test is the performance prediction measure conducted on the bituminous mix. The procedure consists of determination of properties of mix, Marshal Stability and flow analysis and finally determination of optimum bitumen content. The concept of phase diagram is used for the calculations In result the optimum bitumen content is 5.1 %. This is economically satisfying as per IRC 111 2009. By narrow graph, the Marshall Stability test and properties of mix this value is obtained. Depending on project condition, further load, climatic condition this Chennai outer ring road project require 5.1% of optimum bitumen content.