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Validation of Compaction of Bituminous Mix in Roller Compactor cum Rut Analyser (RCRA) For Performance Based Pavement Testing and Mix Design

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***Abstract:** Validation is one of the most important criteria in any research work. Any equipment needs to be validated with well-established and known methods. In this research work, an indigenously developed equipment called Roller Compactor cum Rut analyser (RCRA) is validated to ascertain that the required compaction is achieved.*
***Keywords:** Marshal Method, Bituminous mix, Roller Compactor cum Rut Analyser, Density*

I. INTRODUCTION

The development of transportation infrastructure has been closely linked with the human development. Transportation plays a major role in the development of economy and there by overall development of the country. Road transportation is the most flexible mode of transportation which provides door to door service. With the emerging demand for the development of better roads, pavement types, better design and development has gained high importance.

Rheological properties of bituminous mix materials, climatic conditions, Construction practice severely affects the performance of bituminous pavements. In our country as well in many countries empirical Marshal Mix Method of mix design is being used. However, Marshal Method of Mix Design has its own drawbacks. In this direction to do the performance based pavement design an equipment called Roller Compactor and Rut Analyser is conceptualised, designed and fabricated indigenously, to have more practical approach to pavement testing and design.

A. Types of Pavement

Following are the main types of the pavements.

1) Flexible pavement
2) Rigid pavement
3) Semi rigid pavement

Flexible Pavement: Flexible pavements are those which are flexible in their structural action under the loads.

Some important features of these pavements are:

a) It has negligible flexural strength.
b) The deformation of the lower layers are reflected on the surface.
c) It will transmit the vertical load to bottom layers by grain to grain transfer.
d) The lower layer have to take up only lesser amount of stress, hence inferior materials with low cost can be used in the lower layers.

Flexible pavements consist of the following components.

- Soil subgrade
- Granular Sub base course
- Base course
- Bituminous Binder Course
- Bituminous Surface Course

B. Objective

The main objective of this research work is to validate the compaction achieved for bituminous mix in Roller Compactor cum Rut Analyser.

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II. ROLLER COMPACTOR CUM RUT ANALYSER (RCRA)

The Roller Compactor cum Rut Analyser (Fig 1) is an equipment for pavement testing and bituminous mix design. Using this equipment, the entire layers of pavement can be constructed and the materials can be tested for different parameter by applying wheel load to simulate the actual field condition

It consists of a main steel frame made of channel section fitted with scissors lifting mechanism to raise and lower the moulds. It has the provision for both compaction and rutting using the dedicated rollers. It has a control panel by which the different operations can be controlled.

The moulds are designed to build the different layers of pavement to bring the reality in the testing. The thickness of the different layers prepared/casted in RCRA moulds are as per the standard plates given in IRC 37-2012. The dimension of the mould used is 650 mm X 270 mm with varying heights. The compacted specimen of subgrade and bituminous layer is shown in Fig.2 and Fig.3 respectively.

Fig. 1 Roller compactor and rut analyser

III.METHODOLOGY

The following methodology is adopted for validating the compaction achieved in the bituminous layers

1) The different layers of pavement namely Subgrade, Granular Sub Base (GSB) and Wet Mix Macadam (WMM) are casted in RCRA moulds as per the plates given in IRC37-2012.
2) DBM Grade-II and BC Grade –II layers are prepared in RCRA moulds.
3) Core of 100 mm diameter is extracted using core cutter machine.
4) The density of the specimen obtained by core cutting from the RCRA equipment and from Marshal Stability tests are compared and validated.

Fig. 2 Compacted Sub Grade

Fig. 3 Compacted DBM Grade II Layer in RCRA

A. Aggregates

The aggregates are tested and results obtained shown in the Table.1

TABLE 1
TESTS ON AGGREGATES

SL No.	Name of the Tests	Obtained Results	Method Adopted	Permissible Limit (as per IS/MoRTH)	Remarks
1	Aggregate Impact value test (AIV),%, max	15.16	IS:2386-PartIV	27.0	Satisfactory
2	Abrasion Value, %, max	23.5	IS:2386-Part IV	35.0	Satisfactory
3	Specific Gravity	2.65	IS:2386-Part III	2.5 –3	Satisfactory
4	Water Absorption,%, max	0.32	IS:2386-PartIII	2.0	Satisfactory
5	Shape Test, %, max	17.09	IS:2386-PartI	35.0	Satisfactory
6	Plasticity Index, max	2.5	IS 2720-Part V	4.0	Satisfactory

B. Bitumen

The bitumen binder used in the research work is VG-30. The tests are carried out as per relevant IS/ MoRTH specifications to confirm the suitability of bitumen to use in the bitumen mix (Table: 2)

TABLE 2. TESTS ON BITUMEN

Sl No	Name of the test	Obtained Results	Method adopted	Permissible values as per IS/ MoRTH	Remarks
1	Penetration Value ,mm, min	66.0	IS:1203-1978	45.0	Satisfactory
2	Softening point ,ºC, min	49.0	IS:1203-1978	47.0	Satisfactory
3	Flash & Fire point ,ºC, min	274 and 300	IS:1203-1978	220	Satisfactory
4	Ductility value, cm, min	85.0	IS:1208	75.0	Satisfactory
5	Specific Gravity	1.00	IS:1203-1978	--	--

The obtained job Mix formula (JMF) for the DBM Gr-II is shown in Table No: 3

TABLE 3
JOB MIX FORMULA FOR DBM GRADE-II

Percentages of different sizes of aggregates to be used as per JMF		
20 mm & down Size	13.2 mm & down size	4.75 mm & down size
30	30	40

IV. EXPERIMENTAL RESULTS FOR MARSHAL MIX DESIGN

The Marshal Stability Test is conducted on two different mixes, namely,

1) DBM Grade II with VG-30,

2) DBM Grade II with 10% plastic with 3% Polyphosphoric Acid (PPA)

The obtained Results of Marshall Stability Test is given in the Table 4.

TABLE 4
MARSHAL PROPERTIES FOR DIFFERENT TYPES OF BITUMINOUS MIX

Sl. No	Marshall Property	Obtained Results	
		VG-30	10% Plastic and 3% PPA
1	Optimum Binder Content (OBC), %	5.10	5.10
2	Marshall Stability, kg	1190	1845
3	Flow Value, mm	3.85	4.10
4	Bulk Density, gm/cc	2.355	2.365
5	Volume of Voids, %	3.05	5.10
6	Voids in Mineral aggregate , VMA, %	18.50	16.5
7	Voids Filled with Bitumen, VFB, %	73.0	61.4

The specimens are casted in RCRA using the obtained Optimum Binder Content (OBC) and compacted using compaction mode to the required thickness. To validate the density achieved in RCRA equipment, a core of 100 mm dia is taken out using Core cutting machine and density is found. The obtained results are shown in Table No.5

TABLE 5
COMPARISON OF DENSITY ACHIEVED

Sl. No	Property	Obtained results in Marshall Stability	Obtained results in RCRA equipment	Percentage of Compaction/ Density achieved	Obtained results in RCRA		Percentage of Compaction/ Density achieved
		VG-30			VG-30	10% Plastic and 3% PPA	
1	Density, gm/cc	2.355	2.322	98.6	2.365	2.338	98.9

V. CONCLUSIONS

From the laboratory investigation it can be concluded that the compaction achieved in the RCRA for bituminous mix is more than 98 percent which is obtained by using Marshall Stability method. This proves that, the required density of more that 98% which is required in the field, is achieved by using RCRA equipment in the laboratory.

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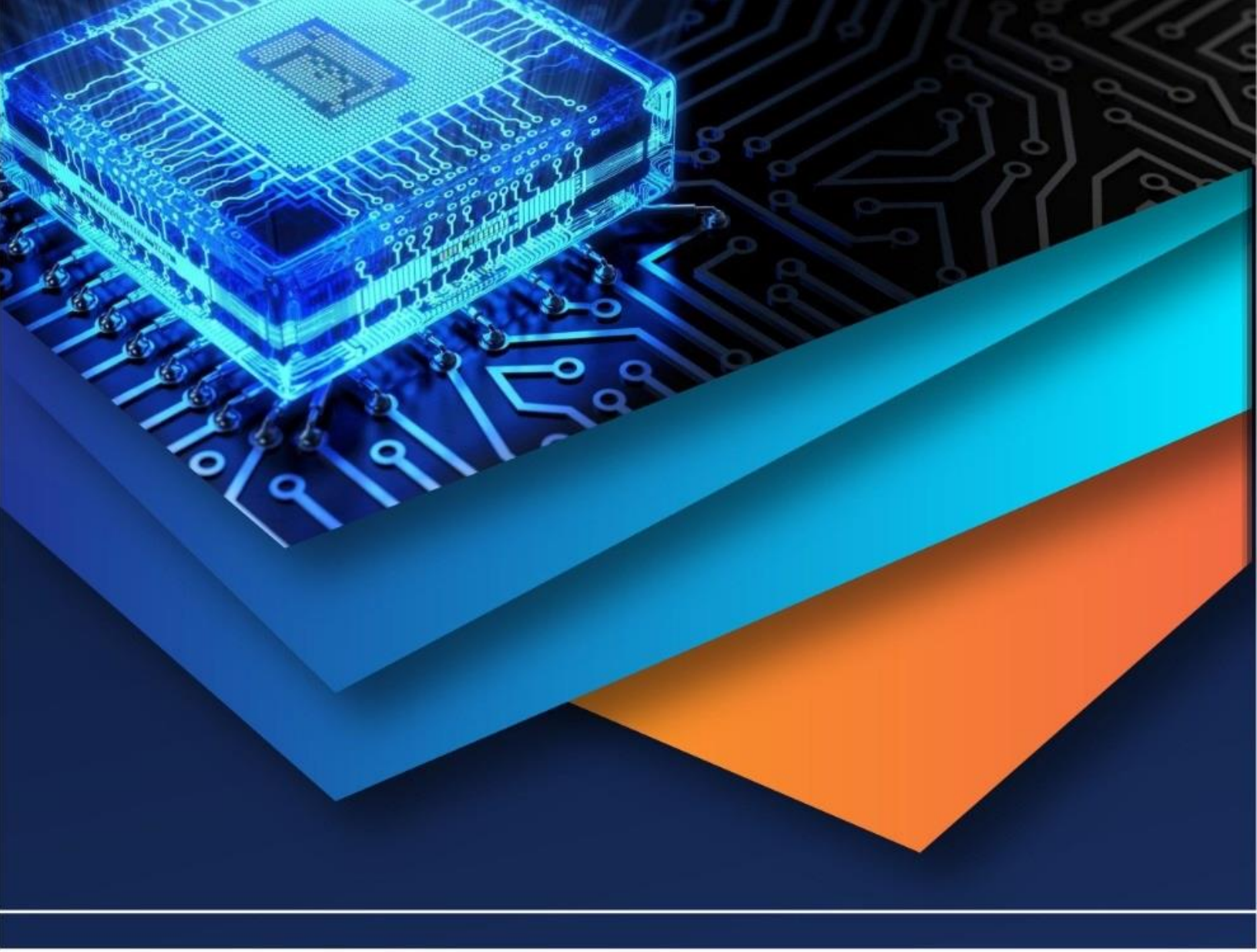

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