The Study of Mix Design of WMM (Wet Mix Macadam)

Salim Khan, Er. Rahul Sikka, Dr. D.P.Gupta, Dr. Arvind Dewangan

Abstract— **This Paper reveals the construction and significance of Four laning of Kaithal - Rajasthan Border Section of NH-152/65 from Km 33+250 (Design Km-0+500) to Km 241.580 (Design Km 165.759) in the State of Haryana under NHDP Phase -IV through Public Private Partnership (PPP) on Design, Build, Finance, Operate and Transfer (DBFOT) Toll Basis.This paper also indicates the huge role of Construction Technology & Management.**

Index Terms— **Highway,Design, Public Private Partnership PPP**
Sub Area: Construction Technology & Management.
Broad Area: Civil Engineering

I. INTRODUCTION

WBM (Water Bound macadam) roads construction:
The water bound macadam road construction technique was given by the John Macadam. This technique in present day is used as given below.
For WBM construction we use three materials:

1. Aggregates
2. Screeners
3. Binders.

Aggregates:
We use the aggregates of different grades. IRC(Indian Roads Congress) has classified the coarse aggregates into 9 grades, according to their size.

For the construction of the WBM roads aggregates are used in the sub-base, base and surface course and so the aggregates are divided into 3 grades according to their size.
Grade 1 - particles of size 90 mm to 40 mm.
Grade 2 - particles of size 63 to 40 mm.
Grade 3 - particles of size 50 to 20 mm.

The grade 1 aggregates having size of 90 mm to 40 mm are preferred for the sub-base material and grade 2 for the base and grade 1 for the surface course. However, if we only use the WBM as the surface course, it gets deteriorated fast due to abrasion with the traffic so, bituminous surfacing over the WBM is general practice.

Screeners are the aggregates of the smaller sizes, generally 12.5 mm or 10 mm, for grade A and grade B. They are of the same chemical composition as of the coarse aggregates.

For economic considerations IRC has suggested non plastic materials such as, crushed over burnt bricks, moorum, gravels, etc. provided the liquid limit of the material is less than 20%, plasticity index is less than 6.0% and the portion of fines passing 0.075 mm sieve is less than 10%. However if crush-able type of aggregates are used, use of the screeners may be disposed off.

Binders:

Binders, are the layers of materials which are laid after the compaction of the aggregates and the screening materials one after the another. Kankar dust or lime stone dust may be utilized if locally available.

The binding material with plasticity index value of 4% to 9% is used in surface course construction; the plasticity index of binding course material should be less than 6% in the case of the WBM layers used as base course or sub-base course, with bituminous surfacing.

However if the screening used are of crushable material like moorum or soft gravel, there is no need to apply binding material, unless the plasticity index value is low.

- **(II) - WMM(Wet mix macadam)** road construction:

Aggregates used are of the smaller sizes, varies between the 4.75 mm to 20 mm sizes and the binders(*stone dust or quarry dust having PI(Plasticity Index) not less than 6%*) are premixed in a batching plant or in a mixing machine. Then they are brought to the site for overlaying and compaction.

The PI(plasticity Index) of the binding material is kept low because it should be a sound and non plastic material. If the plasticity index is more then there are the chances of the swelling and more water retention properties. So this value should be kept in mind.

- ***Comparison of the WBM and WMM road construction:***

Although the cost of construction of the WMM is said to be more than that of the WBM sub-base and bases but the advantages given below will compensate for that. Here are the points of difference:

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1. The WMM roads are said to be more durable.
2. The WMM roads gets dry sooner and can be opened for traffic withing less time as compare to the WBM roads which take about one month for getting dry.
3. WMM roads are soon ready to be black topped with the Bituminous layers.
4. WMM roads are constructed at the faster rate.
5. The consumption of the water is less in case of the WMM roads.
6. Stone aggregates used in WBM is larger in size which varies from 90 mm to 20 mm depending upon the grade but in case of the WMM size varies from 4.75 mm to 20 mm.
7. In case of WBM, stone aggregates, screenings and binders are laid one after another in layers while in WMM, aggregates and binders are premixed in the batching plants and then brought to the site for overlaying and compacting.
8. Materials used in the WBM are the stone aggregates, screenings and binder material(Stone dust with water) while in WMM material used are only stone aggregates and binders.
9. Quantity of the WBM is generally measured in cubic meters while that of the WMM in square meters.

A **public–private partnership** (*PPP* or *3P*) is a commercial legal relationship defined by the Government of India in 2011[1] as "a*n arrangement between a government / statutory entity / government owned entity on one side and a private sector entity on the other, for the provision of public assets and/or public services, through investments being made and/or management being undertaken by the private sector entity, for a specified period of time, where there is well defined allocation of risk between the private sector and the public entity and the private entity receives performance linked payments that conform (or are benchmarked) to specified and pre-determined performance standards, measurable by the public entity or its representative*".

The Government of India recognizes several types of PPPs, including: User-fee based BOT models, User-fee based BOT model, Performance based management/maintenance contracts and Modified design-build (turnkey) contracts. Today, there are hundreds of PPP projects in various stages of implementation throughout the country.

As outlined in its XII Five Year Plan (2012–2017), India has an ambitious target of infrastructure investment (estimated at US$1 trillion). In the face of such an enormous investment requirement, the Government of India is actively promoting PPPs in many sectors of the economy. According to the World Bank, about 824 PPP projects have reached financial closure since 1990 in India.

The Ministry of Finance centralizes the coordination of PPPs, through its Department of Economic Affairs' (DEA) PPP Cell. In 2011, the DEA published guidelines for the formulation and approval of PPP projects. This was part of an endeavor to streamline PPP procedures and strengthen the regulatory framework at the national level to expedite PPP projects approval, reassure private parties and encourage them to enter into PPPs in India. This was one of the main roles of the Public Private Partnership Appraisal Committee (PPPAC) which is responsible for PPP project appraisal at the central level.

The Government also created a Viability Gap Funding Scheme for PPP projects to help promote the sustainability of the infrastructure projects. This scheme provides financial support (grants) to infrastructure projects, normally in the form of a capital grant at the stage of project construction (up to 20 percent of the total project).

The Government has also set up India Infrastructure Finance Company Limited (IIFCL) which provides long-term debt for financing infrastructure projects. Set up in 2006, IIFCL provides financial assistance in the following sectors: transportation, energy, water, sanitation, communication, social and commercial infrastructure.

To help finance the cost incurred towards development of PPP projects (which can be significant, and particularly the costs of transaction advisors), the Government of India has launched in 2007 the 'India Infrastructure Project Development Fund' (IIPDF) which supports up to 75 % of the project development expenses.

Finally, the PPP Cell has produced a series of guidance papers and a 'PPP Toolkit' to support project preparation and decision-making processes. The objective is to help improve decision-making for infrastructure PPPs in India and to improve the quality of the PPPs that are developed. The tookit has been designed with a focus on helping decision-making at the Central, State and Municipal levels.

EMPLOYER :- National Highways Authority of India.	**CONCESSIONAIRE :-** Kaithal Tollway Private Limited.	**EPC CONTRACTOR** :- IRB Infrastructure Developers Limited.	**INDEPENDENT ENGINEER :-** Consulting Engineering Group Limited.

Location:- 41+065 to 51+065

Summary of WMM Design Mix

Location of Stock:- Km. 45+200 LHS

Source of Material:- Mahalaxmi crusher (Tosham)Haryana

Proportion of Aggregate:-

1	**40mm**	**32%**
2	**20mm**	**20%**
3	**10mm**	**20%**
4	**Stone Dust**	**28%**

Test:-

Sample No.	**Grain Size Analysis : % Passing**							
	53.0 MM	**45.0 MM**	**22.4 MM**	**11.2 MM**	**4.75 MM**	**2.36 MM**	**600 Mic.**	**75 Mic.**
1	100	97.61	71.46	47.49	31.31	20.59	11.36	1.89
2	100	98.50	71.70	47.00	30.27	19.73	12.03	2.47
3	100	97.32	69.27	49.92	30.85	20.63	14.99	2.17
Avg.	100	97.81	70.81	48.14	30.81	20.32	12.79	2.18
Specified limit MORT&H Table 400-13	**100**	**95-100**	**60-80**	**40-60**	**25-40**	**15-30**	**.8-22**	**0--5**

S.No.	**Description of test**	**Result obtained**	**Spec. limit**
1	Maximum Dry Density (gm/cc) (Avg. of 3 tests)	2.277	-

2	Optimum moisture content (%) (Avg. of 3 tests)				5.93	-
3	Aggregate impact value (%)				20.13	30% Max.
4	Flakiness + Elongation index FI+EI (%)				28.31	35% Max.
5	Plasticity Index				Non-Plastic	6% Max.
6	WATER ABSORPTION(%)	40	**20**	**10**	Stone Dust	**2% Max.**
		0.60	0.76	1.00	1.95	

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Mix Proportion for WMM

Source :- Mahalaxmi Crusher(Tosham)Haryana

Location of Stock:- 45+200 LHS Danoda Stock Yard

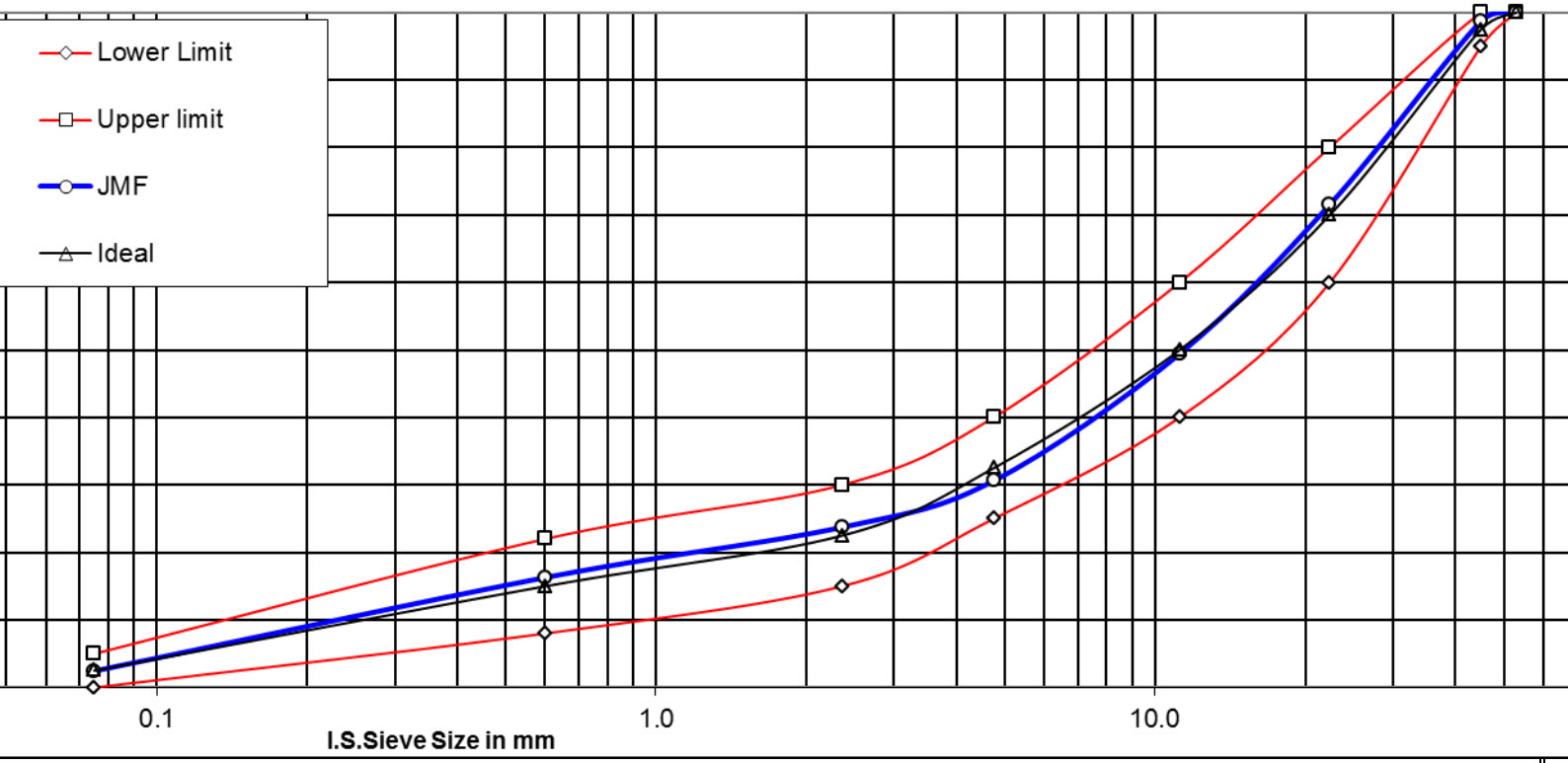
Proportion of Aggregate:-

1	**40mm**	**32%**
2	**20mm**	**20%**
3	**10mm**	**20%**
4	**Stone Dust**	**28%**

IS Sieve Size (mm)	**Individual gradation and its proportion**								**Combined gradation**	**Limit as per MORTH & Table 400-13**
	40 mm		**20 mm**		**10 mm**		**S.Dust**			
	100%	**32.0%**	100%	**20.0%**	**100%**	**20.0%**	100%	**28.0%**	**100.0%**	
53.0	100.0	32.0	100.0	20.0	100.0	20.0	100.0	28.0	**100**	100
45.0	96.02	30.7	100.0	20.0	100.0	20.0	100.0	28.0	**98.73**	95--100

22.4	11.11	3.56	100.00	20.00	100.0	20.0	100.0	28.0	**71.56**	60--80
11.20	0.63	0.20	10.02	2.00	96.16	19.23	100.0	28.0	**49.44**	40--60
4.75	0.0	0.0	1.52	0.30	12.65	2.53	99.25	27.79	**30.62**	25--40
2.36	0.0	0.0	0.0	0.0	1.44	0.29	83.73	23.44	**23.73**	15--30
0.600	0.0	0.0	0.0	0.0	0.0	0.0	58.15	16.28	**16.28**	8--22
0.075	0.0	0.0	0.0	0.0	0.0	0.0	8.73	2.44	**2.44**	0--5

Gradation Curve for WMM BETWEEN SIEVE AND % PASSING



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CONTRACTOR :- KAMAL BUILDER'S

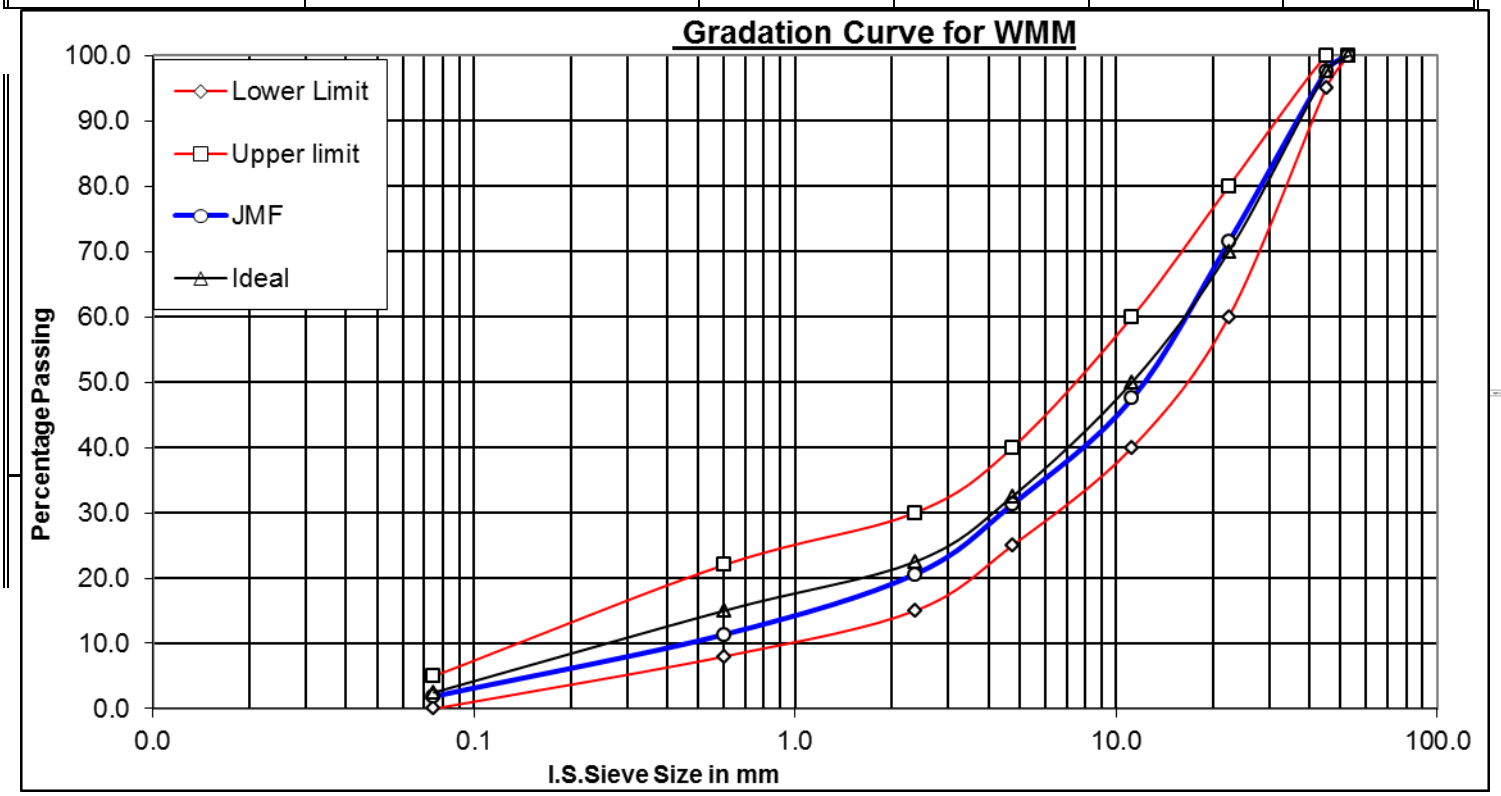
Sieve Analysis for WMM

[As Per MOSRT&H Table 400-13]

Date of Sampling		Date of Testing	
Source of Material	Mahalaxmi Crusher (Tosham) Haryana	Type of Material	40mm-32%, 20mm-20%, 10mm-20% & Stone Dust-28%
Location	Stock Yard Base Camp (Km.45+200 LHS)	Wt. of Dry Sample (gms)	35990

Sample No. 01

IS Sieve Size	Weight Retained	Cum. Weight Retained	Cum. % Retained	% Passing	Specified Limits
(mm)	(gms)	(gms)	(%)	(%)	(%)
53.0	0	0	0	**100**	**100**
45.0	860	860	2.39	**97.61**	**95-100**
22.4	9410	10270	28.54	**71.46**	**60-80**
11.2	8630	18900	52.51	**47.49**	**40-60**
4.75	5820	24720	68.69	**31.31**	**25-40**
2.36	3860	28580	79.41	**20.59**	**15-30**
0.600	3320	31900	88.64	**11.36**	**.8-22**
0.075	3410	35310	98.11	**1.89**	**0-5**



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CONTRACTOR :- **KAMAL BUILDER'S**

Individual Gradation (WMM)

S Sieve	**40 mm**				**20 mm**				**10 mm**				**Stone Dust**			
	1	2	3	**Avg.**	1	2	3	**Avg.**	1	2	3	**Avg.**	1	2	3	**Avg.**
3.0	100	100	100	**100**	100	100	100	**100**	100	100	100	**100**	100	100	100	**100**
5.0	95.27	98.24	94.55	**96.02**	100	100	100	**100**	100	100	100	**100**	100	100	100	**100**
2.4	10.76	11.88	10.69	**11.11**	98.94	100	100	**100**	100	100	100	**100**	100	100	100	**100**
1.20	0.58	0.52	0.78	**0.63**	11.44	10.47	8.15	**10.02**	93.90	96.66	97.92	**96.16**	100	100	100	**100**
.75	0	0	0	**0.00**	0.88	2.11	1.56	**1.52**	11.66	12.30	13.98	**12.65**	99.07	99.38	99.30	**99.25**
.36	0	0	0	**0.00**	0	0	0	**0.00**	1.03	1.35	1.93	**1.44**	91.31	79.38	80.50	**83.73**
.600	0	0	0	**0.00**	0	0	0	**0.00**	0	0	0	**0.00**	62.50	57.94	54.00	**58.15**
.075	0	0	0	**0.00**	0	0	0	**0.00**	0	0	0	**0.00**	8.09	9.69	8.40	**8.73**

Remarks :