

Replacement of Stone Dust to Soil in Wet Mix Macadam

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ABSTRACT: Wet Mix Material includes graded aggregate and granular material, premixed with water. As suitable ingredients in required proportion shall be mixed with MDD and OMC determined as per MORT&H clause 406 for material so blended. In place of granular material like Stone Dust can be replaced to Soil matching the criteria and proceeding other Test Results. From all types of mixes 100% replacement of Stone Dust to Soil with the proper gradation and tests were performed on the Wet Mix Macadam Material. Also it has been that the use of Soil in WMM material has increased the California Bearing Ratio of the Material. The work may be adopted in many layers provided suitable type of compacting is used.

Keywords: Wet Mix Macadam, Soil, stone dust, Replacement of Stone Dust, Flexible Pavement, Highways.

I. INTRODUCTION

Transport system of India has developed like a blood system of society and has contracted the country, the transport of people transport of goods and information has risen indefinitely

throughout the country. It has also directed towards growth in economy from export and tourism from the world. Also allowing to grow the other transportation sectors. Cheap natural Materials has allowed us to travel world, to take the benefits of transportation and more often with limitless freedom. But as we know everything comes at a cost, multiple problems have emerged with heavy traffic and need of people to travel. Moreover, even though other segments of the economy can trust gradually on alternatives, such as renewable energy sources, there are few substitute opportunities for transport. Economic processes are often tangled with material changes, which bring improvement in construction and economic growth. There have been several changes in past such as use of plastic, use of Fly Ash & GGBS, use of GFRP, Use of Mud Bricks and Limestone Dust. In this Research we'll be dealing with change in granular material to Soil in Wet Mix Macadam. A 100% replacement of stone dust to soil is carried out and tested which also satisfies the IRC Code and MoRT&H Specifications. Tests like AIV, LAAV, FI&EI, MDD&OMC & CBR test has been carried out to testify the Material.



Figure 1: Different layers of Road Pavement

Table 1. Waste Material which have been Tried and Tested

Sr. No.	Waste material	Reference
1	Fly Ash	Kute and Deodhar 2003
2	Textile effluent treatment plant (ETP) sludge	Balasubramanian et al.2006
3	Industrial waste collected from industrial waste water treatment plant	Weng et al.2003
4	Granulated blast furnace slag	Malhotra et al.1996
5	Waste paper pulp	Mucahit et al. 2009
6	Limestone dust	Halil et al. 2008
7	Wood sawdust	Turgut et al.2007
8	Polyestrynefoa	Sohrab and Ali 2003
9	Plastic fiber	Hanifi et al.2005
10	Straw	Hanifi et al.2005
11	Cigarette butts	Aeslina et al.2010
12	Cotton waste	Halil et al. 2008
13	Rice husk ash	Rahman et al.1987
14	Processed waste tea	Demir et al. 2006
15	Petroleum effluent treatment plant sludge	Sengupta et al. 2002
16	Welding flux slag	Caroline et al.2009

Role of Soil in Wet Mix Macadam

Soils are made up of sand, silt and clay of diverse combinations. Loams are usually a mix of sand, silt and clay. Dominant particle are often categorized by the name of the soil, for eg. It is found that timaru silt loam has majority of silt. Soil texture can influence whether soils are free difficult, whether they hold water and how easy it is for plant origins to grow. Soil structure designates the way the sand, silt and clay subdivisions are clumped together. Organic substance (decaying plants and animals) and soil organisms like earthworms and bacteria influence soil structure. Clays, organic matter and materials defecated by soil organisms bind the soil particles together to form aggregates. Soil structure is important for plant growth, amendable the movement of air and water, prompting root development and moving nutrient availability. Good quality soils are friable (crumbly) and have fine aggregates so the soil disrupts up easily if you squeeze it. Clays and organic matter in the soil transport negative charges. Water in the soil liquefies nutrients and other chemicals. Nutrients like potassium and

ammonium have positive charges. They are involved to the negatively charged organic and mineral material, and this avoids them from being lost through discharge as water moves through the soil. Nitrate has a negative charge so it is not endangered from leaking in most soils. Soils can be acid, alkaline or neutral. Soil pH influences nutrient interest and plant growth. Some plants, like kumara and potatoes, grow best in a more acidic soil(pH of 5.0-6.0).

Guidelines for WMM in MORT&H & IRC Codes

Wet Mix Macadam (WMM) is a pavement layer wherein crushed, granular, graded aggregates are mixed in pug mill plant and later conveyed to site and rolled into a dense mass on pre prepared surface.

Aggregates:

- Aggregates retained on 4.75mm sieve shall not be more than 90% by weight of gravel/shingle.
- Aggregates must contain two fractured faces on almost every aggregate

- The water absorption in aggregates is maximum of 2% and if exceeds soundness test must be carried out on aggregates.

Table 2. Physical Requirements of aggregates for Wet Mix Macadam

Test	Test Method	Requirements
Los Angeles Abrasion Value or	IS:2386 (Part IV)	40 per cent(Max)
Aggregate Impact Value	IS:2386 (Part IV)	30 per cent(Max)
Combined Flakiness and Elongation index	IS:2386 (Part I)	30 per cent(Max)

Grading of Wet Mix Macadam

The grading of aggregates and fines in specific sieve requires specific limit of grading used for Wet Mix Macadam as per the below table.

Table 3. Grading Requirements of Aggregates on different sieves

IS Sieve	Specific Limit	
	Lower Limit	Upper Limit
53	100	100
45	95	100
22.4	60	80
11.2	40	60
4.75	25	40
2.36	15	30
0.600	8	22
0.425	6	18
0.075	0	5



Figure 2: Gradation of WMM

Fines

- Fines less than .425mm must have plasticity Index PI less than 6.
- Grading of fines on .600mm must be within 5% in all circumstances.
- For other sieves this guideline is not applicable.

Tests performed on samples

There are various tests performed on the sample of Wet Mix Macadam, Gradation, MDD & OMC,

Liquid Limit, Water Absorption, Aggregate Impact Value, Los Angeles Abrasion value, Combined FI&EI, Fractured faces Test & CBR.

Gradation:

The gradation shown below is of the first sample i.e. Wet Mix Macadam with Stone Dust. The gradation shown below is of the second sample i.e. Wet Mix Macadam with Soil. Soil is used instead of Stone Dust replacing 100% quantity of it.

Table 4. Individual Gradation and Average Gradation (i)

40mm Agg Average								20mm Agg Average							
IS Sieve	S-1	S-2	S-3	S-4	S-5	S-6	40mm Avg	IS Sieve	S-1	S-2	S-3	S-4	S-5	S-6	20mm Avg
53	100	100	100	100	100	100	100	53	100	100	100	100	100	100	100
45	100	100	100	100	100	100	100	45	100	100	100	100	100	100	100
22.4	18.92	17.53	19.74	17.23	20.12	18.13	18.61	22.4	89.81	91.39	90.34	90.78	91.34	89.54	90.53
11.2	2.13	2.64	1.65	2.94	3.10	2.13	2.43	11.2	7.57	9.21	8.03	8.23	8.12	9.21	8.39
4.75	0.65	0.57	0.23	0.42	0.85	0.35	0.51	4.75	2.99	4.67	3.37	4.03	4.03	3.52	3.77
2.36								2.36	0.37	1.03	0.64	0.89	0.44	0.47	0.64
0.600								0.600							
0.425								0.425							
0.075								0.075							
10mm Agg Average								Stone Dust Average							
IS Sieve	S-1	S-2	S-3	S-4	S-5	S-6	10mm Avg	IS Sieve	S-1	S-2	S-3	S-4	S-5	S-6	Dust Avg
53	100	100	100	100	100	100	100	53	100	100	100	100	100	100	100
45	100	100	100	100	100	100	100	45	100	100	100	100	100	100	100
22.4	100	100	100	100	100	100	100	22.4	100	100	100	100	100	100	100
11.2	94.10	94.56	93.82	95.03	94.27	93.56	94.22	11.2	100	100	100	100	100	100	100
4.75	3.08	2.66	2.52	2.31	3.34	2.54	2.74	4.75	99.17	98.98	98.30	98.32	97.28	98.77	98.47
2.36	0.72	0.70	0.41	0.69	0.82	0.54	0.65	2.36	70.69	84.41	78.24	78.22	73.20	76.38	76.85
0.600	0.29	0.23	0.17	0.24	0.30	0.21	0.24	0.600	42.44	46.48	43.53	43.49	42.08	44.23	43.71
0.425								0.425	36.90	38.50	37.50	36.10	38.10	38.90	37.67

								5									
0.075								0.075	6.19	7.17	6.96	6.73	7.52	7.03	6.93		

Table 4. Individual Gradation and Average Gradation (ii)

40mm Agg Average								20mm Agg Average							
IS Sieve	S-1	S-2	S-3	S-4	S-5	S-6	40mm Avg	IS Sieve	S-1	S-2	S-3	S-4	S-5	S-6	20mm Avg
53	100	100	100	100	100	100	100	53	100	100	100	100	100	100	100
45	100	100	100	100	100	100	100	45	100	100	100	100	100	100	100
22.4	18.92	17.53	19.74	17.23	20.12	18.13	18.61	22.4	89.81	91.39	90.34	90.78	91.34	89.54	90.53
11.2	2.13	2.64	1.65	2.94	3.10	2.13	2.43	11.2	7.57	9.21	8.03	8.23	8.12	9.21	8.39
4.75	0.65	0.57	0.23	0.42	0.85	0.35	0.51	4.75	2.99	4.67	3.37	4.03	4.03	3.52	3.77
2.36								2.36	0.37	1.03	0.64	0.89	0.44	0.47	0.64
0.600								0.600							
0.425								0.425							
0.075								0.075							
10mm Agg Average								Soil Average							
IS Sieve	S-1	S-2	S-3	S-4	S-5	S-6	10mm Avg	IS Sieve	S-1	S-2	S-3	S-4	S-5	S-6	Soil Avg
53	100	100	100	100	100	100	100	53	100	100	100	100	100	100	100
45	100	100	100	100	100	100	100	45	100	100	100	100	100	100	100
22.4	100	100	100	100	100	100	100	22.4	100	100	100	100	100	100	100
11.2	94.10	94.56	93.82	95.03	94.27	93.56	94.22	11.2	100	100	100	100	100	100	100
4.75	3.08	2.66	2.52	2.31	3.34	2.54	2.74	4.75	100	100	100	100	100	100	100
2.36	0.72	0.70	0.41	0.69	0.82	0.54	0.65	2.36	70.13	78.88	75.67	78.87	72.10	73.56	74.87
0.600	0.29	0.23	0.17	0.24	0.30	0.21	0.24	0.600	46.34	48.98	50.23	48.89	51.11	43.85	48.23
0.425								0.425	30.56	33.89	32.20	33.56	31.78	31.34	32.22
0.075								0.075	5.21	5.94	5.80	5.56	5.11	5.24	5.48

Blending of Wet Mix Macadam

Blending is a process that blends available material to meet the specified gradation limits. Now a days, it is a multipurpose optimization process that involves minimal costing and satisfying specifications. The blending shown below is of Wet Mix Macadam with Stone Dust.

Blending of Wet Mix Macadam								
IS Sieve	37%	17%	16%	30%	Blending	Mid Limit	Specific Limit	
	40mm	20mm	10mm	Dust			Lower Limit	Upper Limit
53	100.00	100.00	100.00	100.00	100.00	100.0	100	100
45	100.00	100.00	100.00	100.00	100.00	97.5	95	100
22.4	18.61	90.53	100.00	100.00	68.28	70.0	60	80
11.2	2.43	8.39	94.22	100.00	47.40	50.0	40	60
4.75	0.51	3.77	2.74	98.47	30.81	32.5	25	40
2.36		0.64	0.65	76.85	23.27	22.5	15	30
0.600			0.24	43.71	13.15	15.0	8	22
0.425				37.67	11.30	12.0	6	18
0.075				6.93	2.08	2.5	0	5

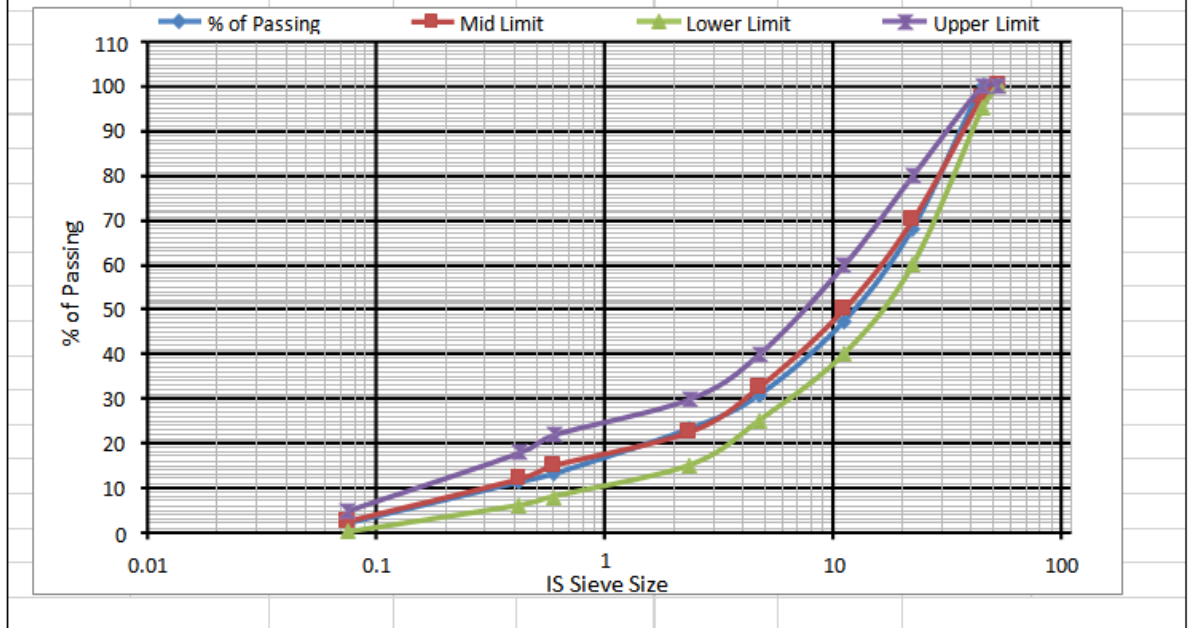
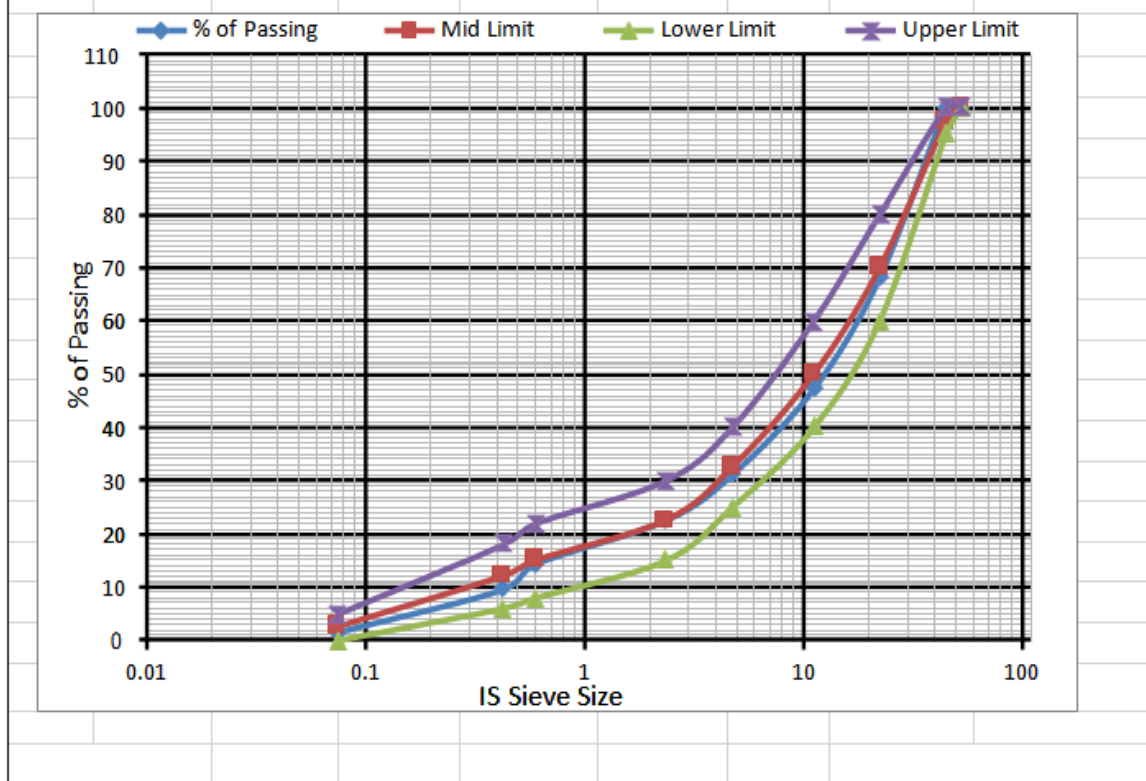


Table 5. Blending of Wet Mix Macadam with Stone Dust (i)

In this blending of Wet Mix Macadam stone dust is replaced to soil completely. And the blending is in perfect order as required by the wet mix macadam. The blending shown below is of Wet Mix Macadam with Soil.

Table 5. Blending of Wet Mix Macadam with Soil (ii)

Blending of WMM with Soil								
IS Sieve	37%	17%	16%	30%	Blending	Mid Limit	Specific Limit	
	40mm	20mm	10mm	Soil			Lower Limit	Upper Limit
53	100.00	100.00	100.00	100.00	100.00	100.0	100	100
45	100.00	100.00	100.00	100.00	100.00	97.5	95	100
22.4	18.61	90.53	100.00	100.00	68.28	70.0	60	80
11.2	2.43	8.39	94.22	100.00	47.40	50.0	40	60
4.75	0.51	3.77	2.74	100.00	31.27	32.5	25	40
2.36	0.00	0.64	0.65	74.87	22.67	22.5	15	30
0.600	0.00	0.00	0.24	48.23	14.51	15.0	8	22
0.425	0.00	0.00	0.00	32.22	9.67	12.0	6	18
0.075	0.00	0.00	0.00	5.48	1.64	2.5	0	5



There are several other tests performed on the two samples of Wet Mix Macadam. For a research paper which would not be appropriate to describe. Therefore, a summary is being used to exhibit the sample.

Table 6. Summary of Tests performed on Wet Mix Macadam with Stone Dust (i)

Sl. No	Description	Reference MoRT&H / IS Codes	Test Result	Specification Limit
1	Gradation	MORTH Table 400-13	Within Specification Limit	As per MoRT&H table 400-13

2	M.D.D (gm/cc)	IS:2720 (PART-VIII)	2.33	-
3	O.M.C (%)	IS:2720 (PART-VIII)	5.15	-
4	Liquid Limit (%)	IS:2720 (PART-V)	18.13	Max. 25%
5	Plasticity Index (%)	IS:2720 (PART-V)	Non Plastic	Max. 6%
6	Water Absorption (Fine Aggregate) (%)	IS:2386 (PART-III)	1.779	Max. 2%
7	Water Absorption (Coarse Aggregate 40mm) (%)	IS:2386 (PART-III)	0.232	Max. 2%
8	Water Absorption (Coarse Aggregate 20mm) (%)	IS:2386 (PART-III)	0.553	Max. 2%
9	Water Absorption (Coarse Aggregate 10mm) (%)	IS:2386 (PART-III)	0.764	Max. 2%
10	AIV (%) (Dry Condition)	IS:2386 (PART-IV)	12.83	Max.30%
11	LAAV 40mm (%)	IS:2386 (PART-IV)	19.99	Max.40%
12	LAAV 20mm (%)	IS:2386 (PART-IV)	21.34	Max.40%
13	LAAV 10mm (%)	IS:2386 (PART-IV)	25.95	Max.40%
14	Combind FI+EI(%)	IS:2386 (PART-I)	28.08	Max.35%
15	% of Fractured faces	MORTH Sec 406.2.1.1	100	Min.90%

Table 6. Summary of Tests performed on Wet Mix Macadam with Soil (ii)

Sl. No	Discription	Reference MoRT&H / IS Codes	Test Result	SpecificationLimit
1	Gradation	MORTH Table 400-13	Within Specification Limit	As per MoRT&H table 400-13

2	M.D.D (gm/cc)	IS:2720 (PART-VIII)	2.265	-
3	O.M.C (%)	IS:2720 (PART-VIII)	5.950	-
4	Liquid Limit (%)	IS:2720 (PART-V)	23.000	Max. 25%
5	Plasticity Index (%)	IS:2720 (PART-V)	3.440	Max. 6%
6	Water Absorption (Fine Aggregate) (%)	IS:2386 (PART-III)	1.779	Max. 2%
7	Water Absorption (Coarse Aggregate 40mm) (%)	IS:2386 (PART-III)	0.232	Max. 2%
8	Water Absorption (Coarse Aggregate 20mm) (%)	IS:2386 (PART-III)	0.553	Max. 2%
9	Water Absorption (Coarse Aggregate 10mm) (%)	IS:2386 (PART-III)	0.764	Max. 2%
10	AIV (%) (Dry Condition)	IS:2386 (PART-IV)	13.630	Max.30%
11	LAAV 40mm (%)	IS:2386 (PART-IV)	22.130	Max.40%
12	LAAV 20mm (%)	IS:2386 (PART-IV)	23.600	Max.40%
13	LAAV 10mm (%)	IS:2386 (PART-IV)	25.870	Max.40%
14	Combnd FI+EI(%)	IS:2386 (PART-I)	28.540	Max.35%
15	% of Fractured faces	MORTH Sec 406.2.1.1	100.000	Min.90%

II. FUTURE SCOPE OF STUDY

To study further on this material of Wet Mix Macadam with Soil

- California Bearing ratio test can be performed and compared with Wet Mix macadam with StoneDust.

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