"Strengthening of the Bituminous Road by Utilizing Dimensioned Stone Waste"

Abhishek Mudgal [(1)], Nandeshwar lata [(2)] , Bharat nagar [(3)]

[1]M.Tech scholar, [2] Assistant Professor, [3]Professor,
Department of Civil Engineering, Jagannath University Chaksu, Rajasthan, India

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ABSTRACT: The humans have a tendency to trade on the resources of natural to accomplish their day by day needs. Road network of any country shows its level of development the well developed and connected network of roads shows the level of development. Roads are the financial life saver for an evolutive nation like India and economical advancement is the way to future.

Road construction required raw material i.e. Bitumen, Aggregate, Earth etc. These materials are natural resources which increase the consumption which makes the depletion of natural resources. Due to depletion of natural resources make human switch to alternative material available for construction.

The development of pavement can also be done by using dimensioned stones, and it has also been studied in the recent researches of the years. The waste like Kota Stone and Marbles are there in ample quantity. Dimension stone that is in form of fine grains (Kota stone) are mined in and around Kota district and on other hand Dimension stone that is in form of fine grains (Marble stone) are mined in and around Kishangarh area. Polishing, cutting and sawing are the general process that has been done just after mining, and all these polishing process generates material in form of waste and that is non-biodegradable.

This study mainly focus on using Kota stone, Marble stone waste as a form of aggregate and Marble dust as a filler material at 20, 40, 60, 80 and 100 % of replacement to natural material in various layer of Flexible Pavement. Flexible pavement layer consider for this study are Granular Sub-Base (GSB) grade I & II, Wet Mix Macadam (WMM) and Bituminous Macadam (BM) grade Ieach layer has its own importance and having coarse and fine aggregate in different proposition. Replacements of natural aggregate with Dimensioned stone waste in these layers are examined on parameter like Proctor test, CBR test, Marshall Stability Test. Engineering properties of Kota stone and Marble stone waste are compared to natural material as per MoR&TH recommended test procedure.

Key Words: Marshall Stability Test,CBR Test, BM, GSB,BM, WMM, Proctor Test.

1. INTRODUCTION

1.1 Problem Statement

The efficient use of resources that are not renewable is the main requisite of today's time, the population is increasing exponentially and so the use of natural resources is also increasing, now-a-days most of the people are much aware on the point that the use of natural resources should be limited and efficient. For fulfillment the demand over mining is done that cause adverse effect on environment. The mining products are in very much use for development works. And these mining works leaves behind the mining waste. These wastes are disposed directly in to the surrounding environment, and this kind of practice can motivate lots of the environmental problems. Rajasthan is very popular for its Marble and Kota Stone use in floor finishing and other works. At the time of dimensioning those lots of stones waste is generated which directly dispose in environment which causes adverse effect.

1.2 Kota Stone

It is a kind of special stone that is in very much use, it belongs to the limestone family of stones. The occurrence of this stone is basically from Kota (Rajasthan). It has presence of acidic agents in it, and due to their presence in it, it dissolve readily. It has been observed that the acid that is low in strength can also make it dissolved. The nature and type of acid sometimes makes the result of reaction varying, so it also depends of acid nature. Various types of by-products are produced due to reaction of sulfate, chloride and nitrate reacting with this kind of carbonate rock, all these chemical react differently with it. The produced by-products have a large solubility range, and also it has been seen that the durability is also got impacted.

Fig .1.1Kota Stone Waste

Marble Stone

India has achieved the third position in production of dimensional stone. Rajasthan that is situated in western part of India is the hub of its major production. It has been noted that the major production that is around sixty five percent of overall stone is done only in this area. In the construction of residential buildings granite and marble stones are used more often. Polishing, cutting and sawing are the general process that has been done just after mining of these stones from mines, and the powder waste generated during all these process is considered worthless. This generated waste is disposed without any specific standard and this become a grievous case to be considered by stone industry. The waste generated is about ten millions ton per year and this is really a huge volume. This much waste can fill any of accessible dumping area in very less time. These powdered wastes severely impact the environment by all the means; and also cause bad impacts on human health.

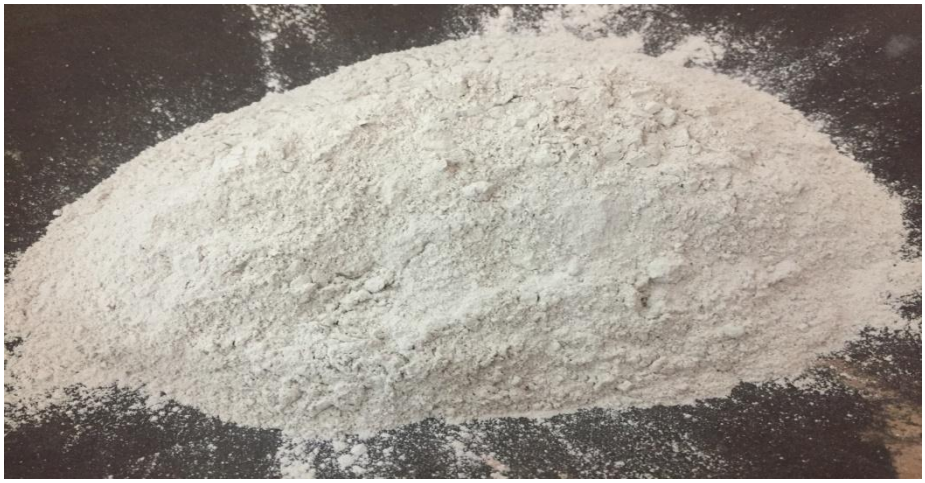

Fig .1.2Marble CuttingWaste

Objectives of Study

- Reduction in usage of natural aggregate.
- Replace natural aggregate with Kota Stone and Marble Stone waste in different layer.
- Engineering properties analysis of Kota Stone and Marble stone.
- Engineering properties comparison of Kota Stone and Marble stone waste with Natural Aggregate.
- To evaluate the MDD, OMC and CBR at Various percent of replacement with Kota Stone and Marble Stone waste.

2. LITERATURE SURVEY

Pradeep Kumar Gautam, Dr. PawanKalla(2018) et.al have investigate on hot mix asphalt with various proportion of mining waste. They conducted different laboratory test on bituminous mix as per the IRC recommendation.

- Lime stone of Kota also known as Kota stone is used HMA in proportion of 25%, 50%,75% and100% replacement with natural aggregate.
- Kota stone is consider for DBM (G-II) and BC (G-II) and layer in HMA.
- The study has denoted that 50% kota stone waste can be used in BC layer and 25% kota stone waste can show feasible result while used in DBM layer.

Surender Singh et.al. (2017) examine the usage of agrarian industry waste like sugarcane bagasse ash and waste creating at road demolition site (RAP). They have used this waste for creation of cement blends. They have made a set up of 5 different blends by fractional supplanting characteristic aggregate. Half and full supplanting of coarse RAP (CR) and also half and full supplanting fine RAP (FR) is been done. Three resulting blends were set up by 10% and 15% Bagasse Ash (BA) individual substitution and full ie hundred percent RAP aggregates mixed with said prepared blend. The outcomes denote that when utilizing of FR aggregates diminished the new, mechanical and sturdiness properties when contrasted with CR totals. One percent RAP utilised altogether with ten percent BA shows the good mechanical and solidness properties. Monetary investigation of the studied blends demonstrated that there is forty percent reduction in all over cost of one meter cube regular cement has been seen when RAP is used with BA. From the examination, 10 percent supplant of concrete by BA in RAP concrete is mentioned as good performing as reinforcing of the asphalt as well as furnishes with natural and monetary advantages are seen there.

PawanKalla, Ravindra Nagar (2018) et.al use of quarry waste in open friction course graded has been focused in this study. SEM known as scanning microscope for electron has been used to analyze the mix properties. Some other tests as falling head permeability test, drain down test also done to observe properties of mix.

Sample prepared at various percentages ranging from twenty five percent to full percent replacement with natural aggregate taking interval of twenty five percent.

3. LABORATARY INVESTIGATION

Material Used

3.1.1Kota Stone Waste

It is a kind of special stone that is in very much use, This is fine-gained stone and it belongs to the limestone family of stones; quarried at Kota district, Rajasthan. In this project the Kota stone waste is collected near Kota district and crushed in required size.

3.1.2 Waste of Marble Stone

The collection of Marble Stone waste is done from Kishangarh district, Rajasthan for the project purpose and crushed in desired size.

3.1.3 Natural Aggregate

These are very vital part of any construction and development. First and very important material that has to be considered for development of new road is aggregate. Significant bit of the asphalt structure are aggregates. Aggregate in distinctive size is utilized for various layer of flexible asphalt. Harmada, Jaipur is the site from where the collection of aggregate has been done.

3.1.4 Bitumen

The bitumen is a vital material for any kind of black-top construction; The Unseasoned petroleum's fragmental distillation produces Bitumen as a by-product. In flexible pavements bitumen is used as a fixative and it has visco-elastic property. VG-40 grade bitumen is been used in this venture.

Table 1 GSB Grade I Job Mix

Sieve Size (mm)	% Passing													
	"60		40		20		"10		6		"Dust			MoR&TH Recommended
	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Combined	
Mix		5%		10%		22%		31%		17%		15%	100%	Grade I
75	100	5	100	10	100	22	100	31	100	17	100	15	100.0	100
53	24.4	1.22	100	10	100	22	100	31	100	17	100	15	96.2	80-100
26.5	4	0.2	19.2	1.92	100	22	100	31	100	17	100	15	87.1	55-90
9.5	0	0	2.4	0.24	29.2	6.42	84.6	26.2	100	17	100	15	64.9	35-65
4.75	0	0	0.6	0.06	8.5	1.87	14.4	4.5	71	12.07	100	15	33.5	25-55
2.36	0	0	0	0	2.3	0.51	5.3	1.6	18	3.06	100	15	20.2	20-40
0.425	0	0	0	0	0	0	2.2	0.7	2.4	0.41	64	9.6	10.7	10-15
0.075	0	0	0	0	0	0	0.7	0.2	0.6	0.10	4.2	0.63	0.9	0-5

Table 2 GSB Grade II Job Mix

Sieve Size (mm)	% Passing											MoRTH Recommended
	40"		20		"10		6		"Dust			
	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Combined	
Mix		10%		12%		15%		42%		21%	100%	Grade II
53	100	10	100	12	100	15	100	42	100	21	100.0	100
26.5	19.2	1.92	100	12	100	15	100	42	100	21	91.9	70-100
9.5	2.4	0.24	29.2	3.504	84.6	12.69	100	42	100	21	79.4	50-80
4.75	0.6	0.06	8.5	1.02	14.4	2.16	71	29.82	100	21	54.1	40-65
2.36	0	0	2.3	0.276	5.3	0.795	32	13.44	100	21	35.5	30-50
0.425	0	0	0	0	2.2	0.33	2.4	1.008	60	12.6	13.9	10-15
0.075	0	0	0	0	0.7	0.105	0.6	0.252	4.2	0.882	1.2	0-5

Table 3 WMM Job Mix

Sieve Size (mm)	% Passing											
	"40		20		"10		6		"Dust			
	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Combined	MoR&TH Recommended
Mix		18%		24%		24%		16%		18%	100%	
53	100	18	100	24	100	24	100	16	100	18	100.0	100
45	85.32	15.36	100	24	100	24	100	16	100	18	97.4	95-100
22.4	0.61	0.11	88.9	21.34	100	24	100	16	100	18	79.4	60-80
11.2	0.03	0.01	1.74	0.42	97.5	23.4	98.7	15.8	100	18	57.6	40-60
4.75	0	0	0.04	0.01	40.6	9.7	75.8	12.1	100	18	39.9	25-40
2.36	0	0	0	0	18.4	4.4	10.5	1.7	95.5	17.2	23.3	15-30
0.6	0	0	0	0	0	0	5.1	0.82	48.8	8.78	9.6	8-22
0.075	0	0	0	0	0	0	1.5	0.24	7.1	1.28	1.5	0-5

Table 4 BM Layer-Grade I Job Mix

Size of sieve (mm)	% Passing											
	"40		20		"10		6		"Dust			
	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Passing	Trail	Combined	MoR&TH Recommended
Mix		25%		35%		25%		10%		5%	100%	GI
45	100	25	100	35	100	25	100	10	100	5	100.0	100
37.5	100	25	100	35	100	25	100	10	100	5	100.0	90-100
26.5	19.2	4.8	100	35	100	25	100	10	100	5	79.8	75-100
13.2	2.4	0.6	29.2	10.2	84.6	21.15	100	10	100	5	47.0	35-61
4.75	0.6	0.15	8.5	2.98	14.4	3.60	71	7.10	100	5	18.8	13-22
2.36	0	0	2.3	0.80	5.3	1.33	18	1.80	100	5	8.9	4-19
0.3	0	0	0	0	2.2	0.55	2.4	0.24	64	3.2	4.0	2-10
0.075	0	0	0	0	0.7	0.18	0.6	0.06	4.2	0.21	0.4	0-8

4. RESULTS AND DISCUSSION

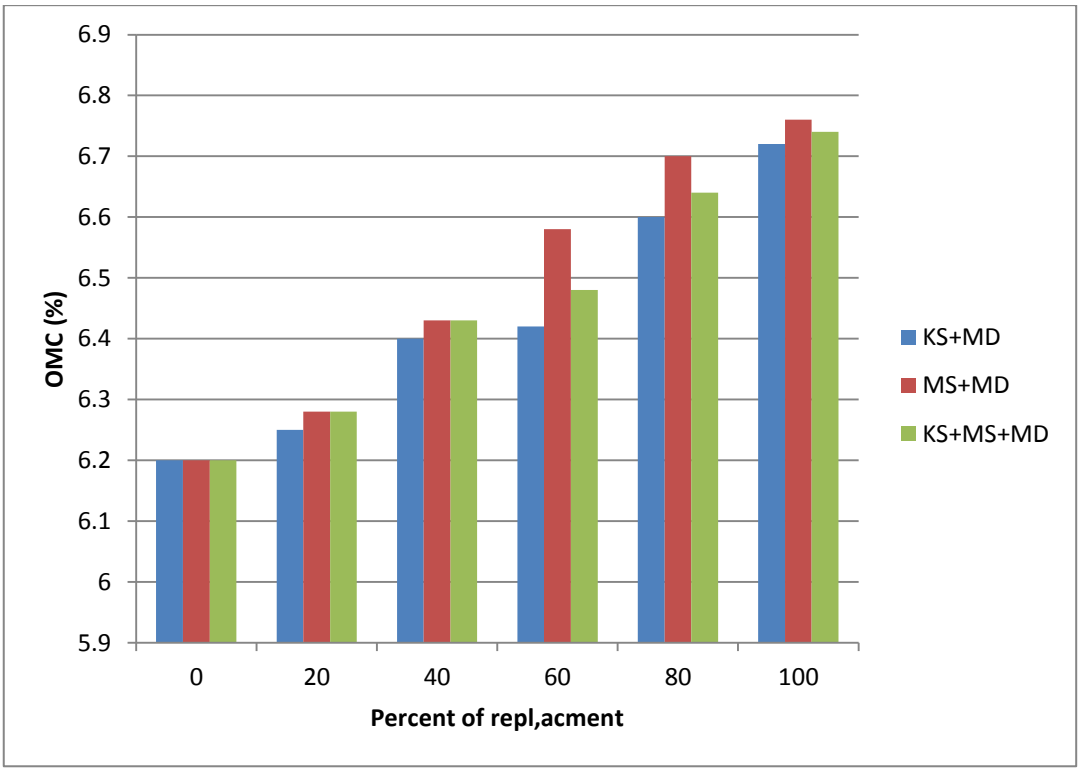

Fig. 1 Comparative OMC value of GSB grade I with Various wastes

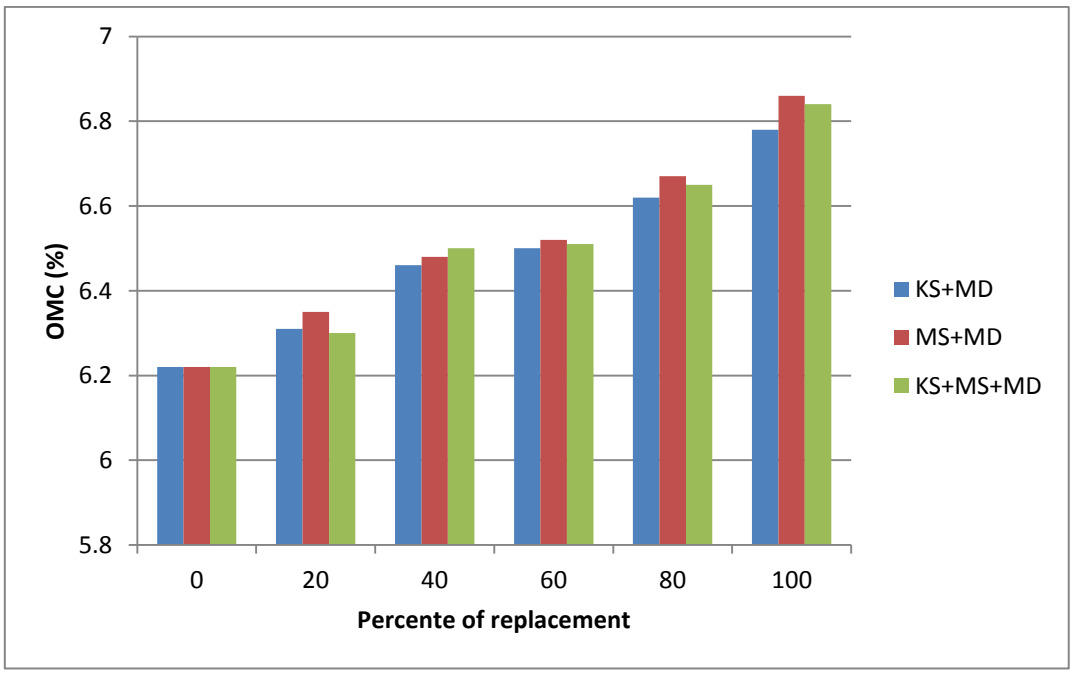

Fig. 2 Comparative OMC value of GSB grade II with various wastes

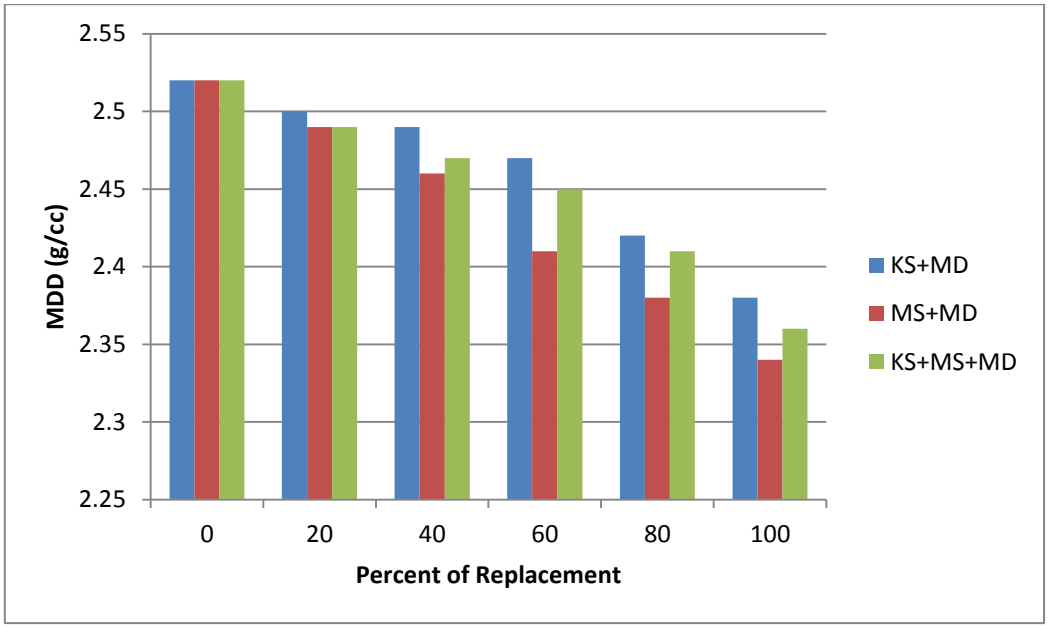

Fig. 3 Comparative MDD value of GSB grade I with various wastes

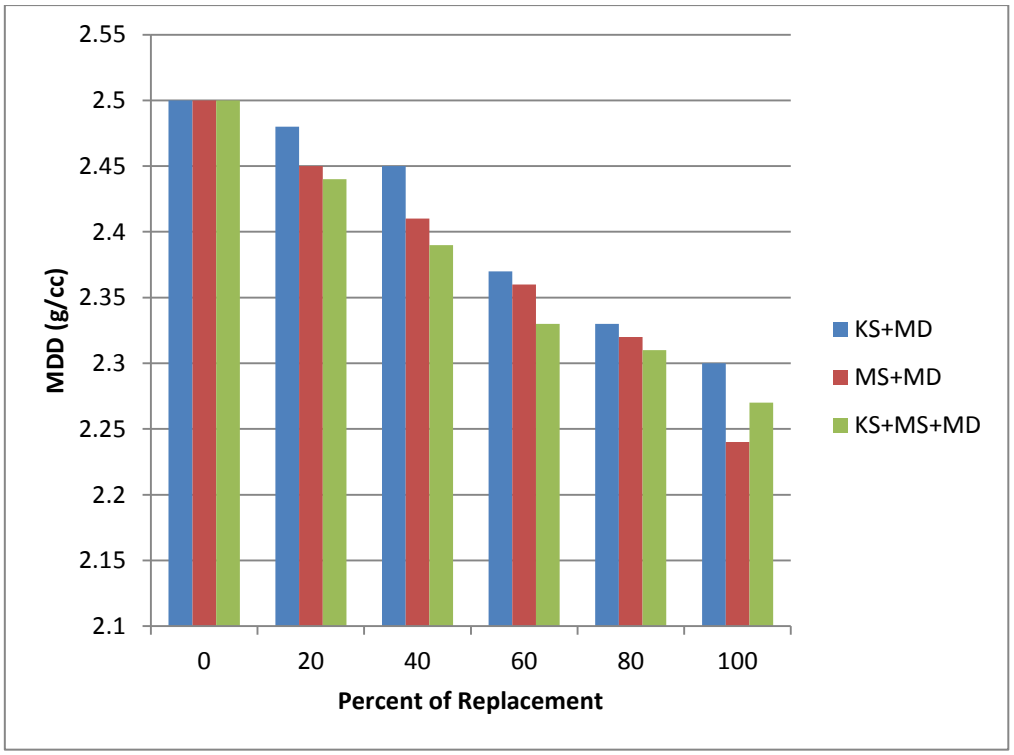

Fig. 4 Comparative MDD value of GSB grade II with various wastes

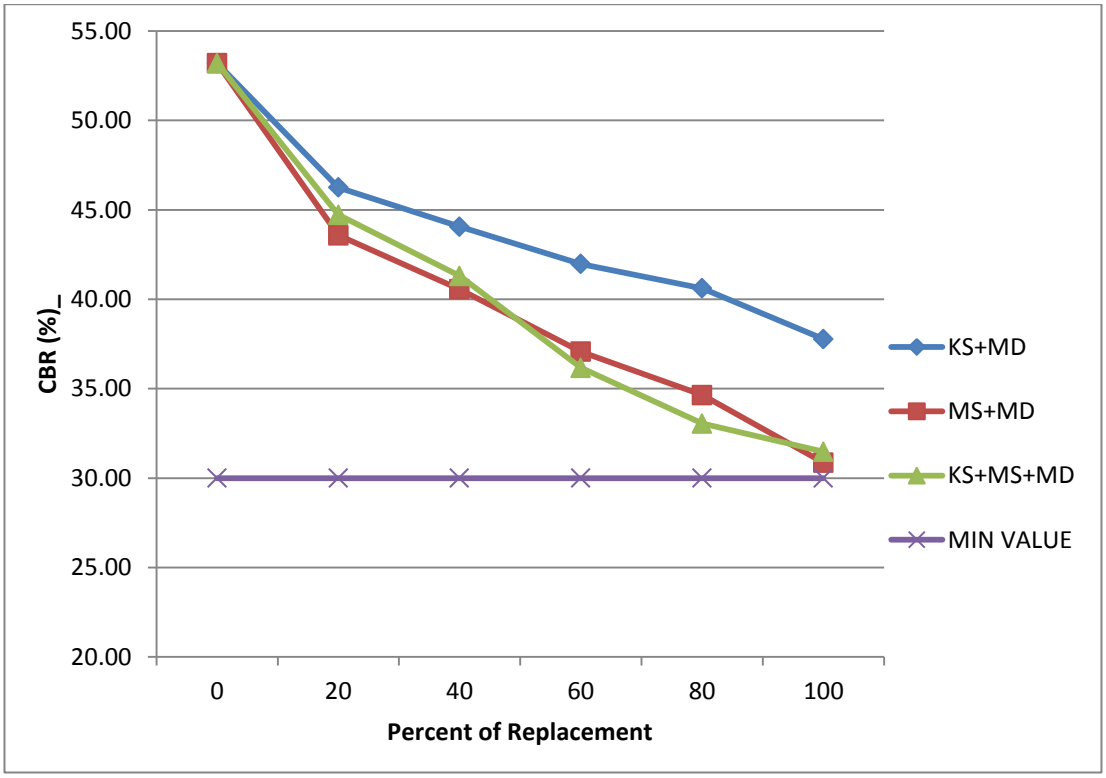

Fig. 5 Comparative Soaked CBR value of GSB grade I with various wastes

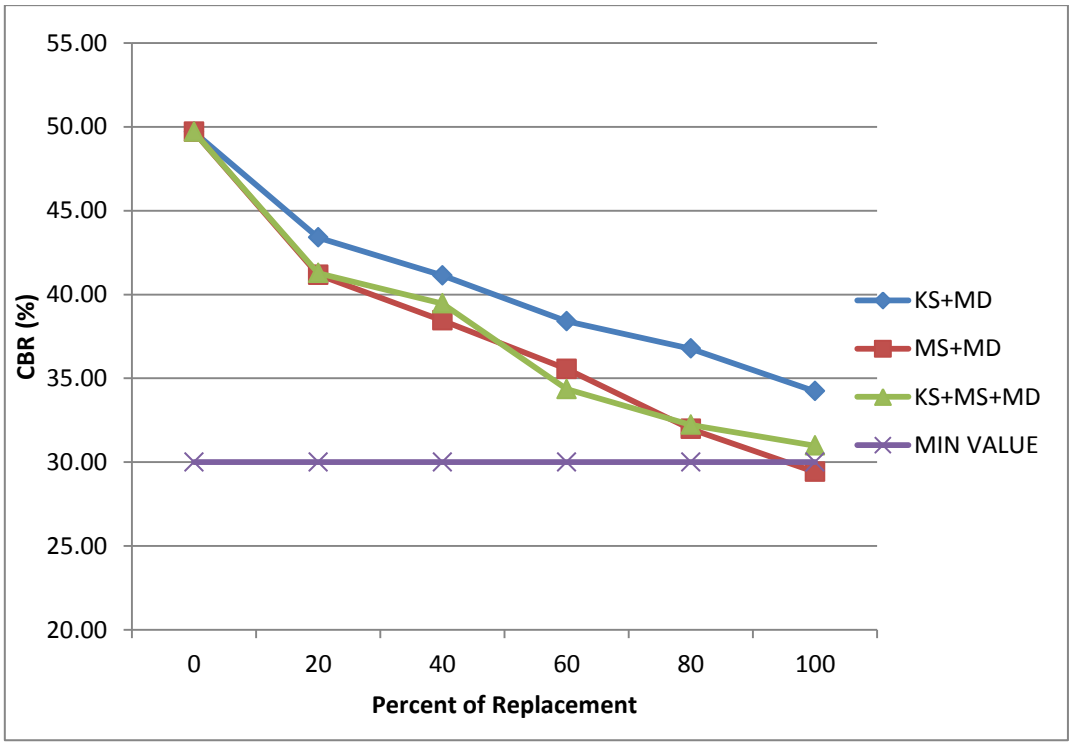

Fig. 6 Comparative Soaked CBR value of GSB grade II with various wastes

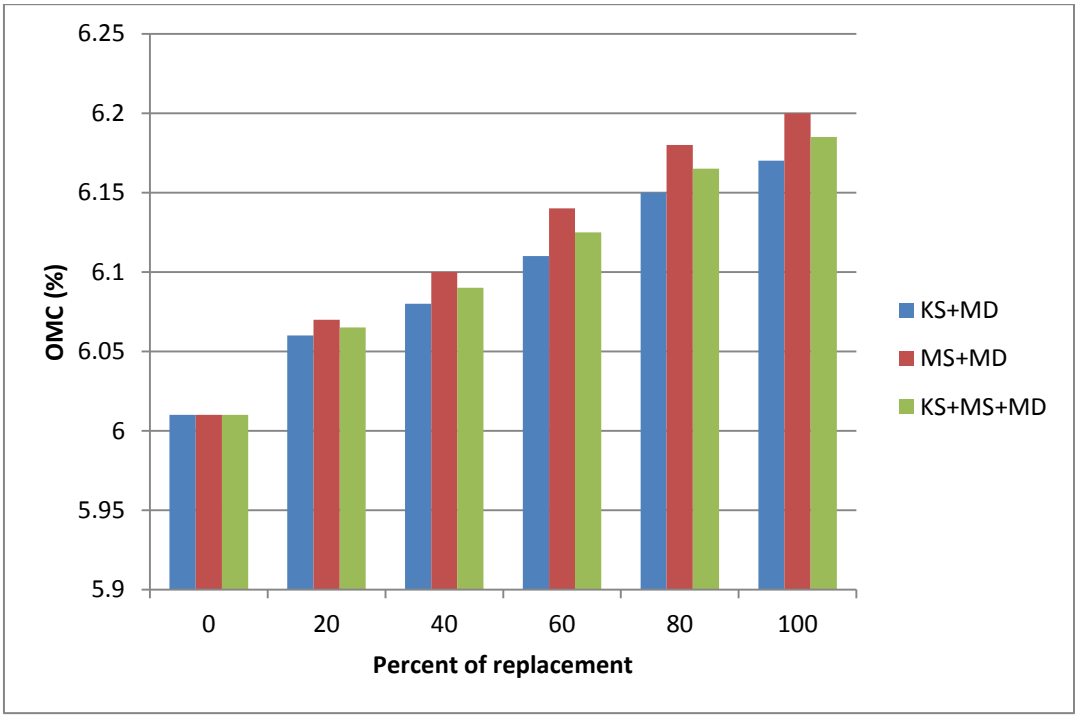

Fig.7 Comparison in OMC value of WMM with different waste

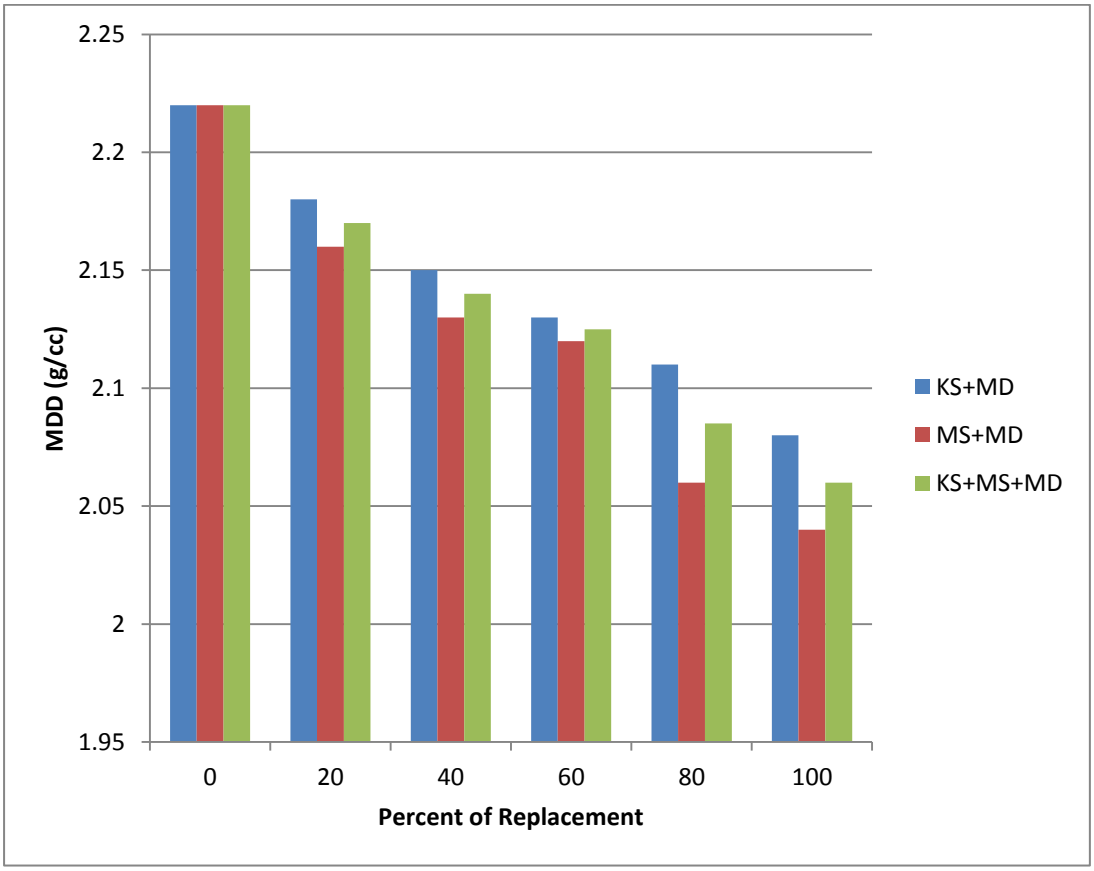

Fig. **8 Comparison in MDD value of WMM with different waste**

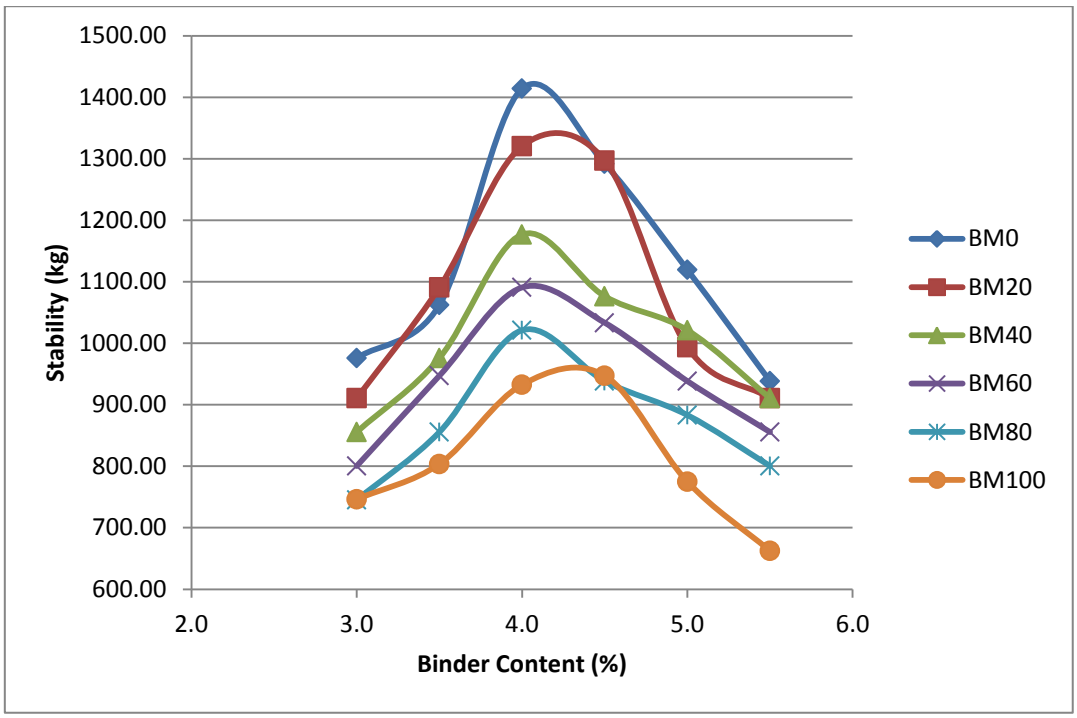

Fig. 9 Comparison of Marshall stability at different binder content

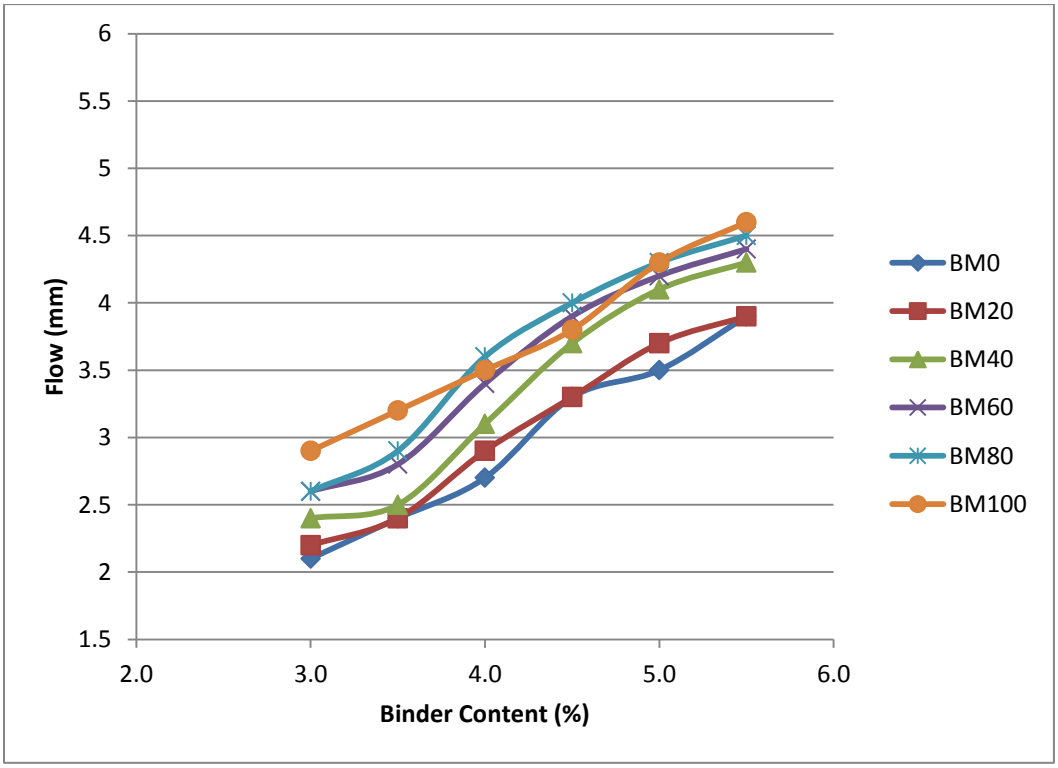

Fig. 10 Comparison of flow value at different binder content

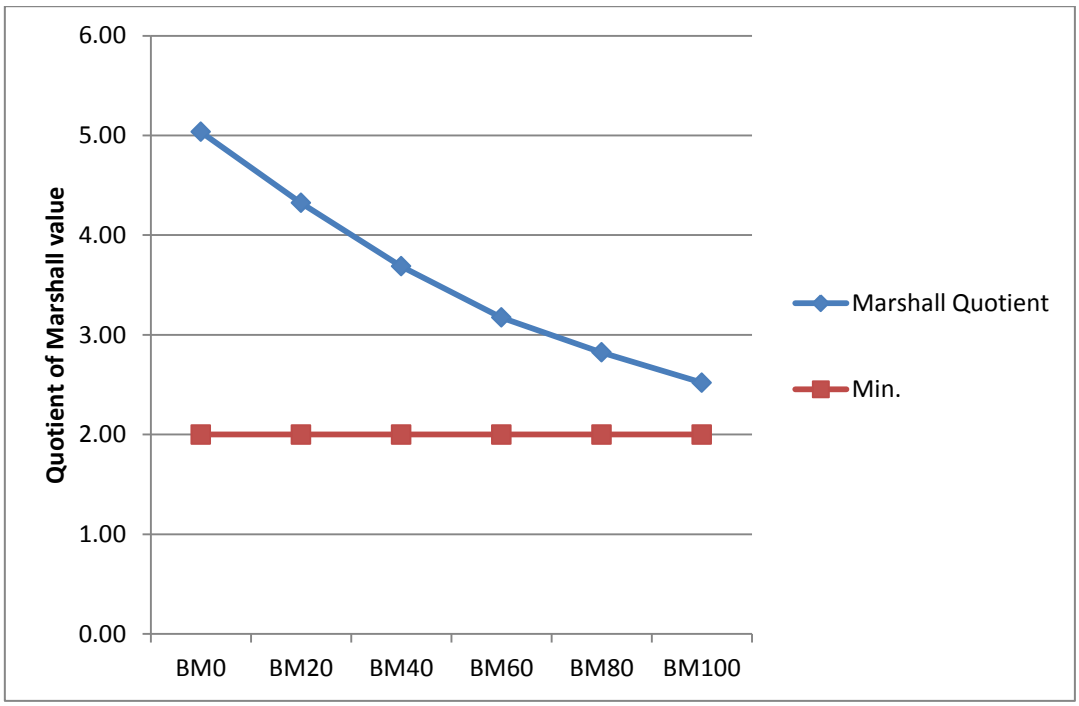

Fig. 11 Comparison Marshall Quotient at different percent of replacement

5.1 Conclusion

5.1.1 Granular Sub Base Layer

- CBR results of grade I & II decreased with increment of percentage replacements of Kota stone waste and marble dust. When we fully replace natural material with kota stone and marble dust CBR result reached upto minimum range which is not suitable for any type of construction, so it is suggested to allow the replacement to be done upto maximum limit of 70%.
- CBR results of grade I & II decreased with increment of percentage replacements of marble waste and marble dust. When we fully replace natural material with marble stone and marble dust CBR result reached upto minimum range which is not suitable for any type of construction, so it is suggested to allow the replacement to be done upto maximum limit of 60%.
- After performing test combined mixture of Kota stone and marble stone with Marble dust as filler in an equal proportion gave average result of individual mixes, so it can be used upto the range of 65% replacement.

5.1.2 Wet Mix Macadam Layer

Following observation was made when Modified proctor test performed.

- Optimum moisture content of mixes is increasing with respect of increase in percent of replacement of various waste materials.
- Maximum dry density at OMC is decreasing with increment of replacement of waste material.
- As there is no strength parameter recommended by MoR&TH for WMM layer, so fully replacement of natural material is not preferable because no guidelines.
- According to the observations and test results,kota stone with marble dust should be usedupto 75%, marble stone with marble dust upto 65% and mixture of kota stone with marble stone in equal proportion should be used upto 70% of replacement of natural material.

5.1.3 Bituminous Macadam Layer

- Optimum Binder content slightly increase with replacement till 20% then it is decrease after 40% till 80% after its values randomly increases.
- OBC values are nearly same as control mix OBC from range of 40 to 80%.
- Marshall Stability results of Bituminous Macadam grade I decreased with increment of percentage replacements of marble waste and marble dust. When we fully replace natural material with marble stone and marble dust Stability result reached upto minimum range which is not suitable for any type of construction, so it is suggested to allow the replacement to be done upto maximum limit of 60-65%.

- Flow values of Bituminous Macadam grade I increasing with increment of percentage replacements of marble waste and marble dust.

REFERENCES

1. A.R. Pasandín, I. Pérez, "Laboratory evaluation of hot-mix asphalt containing construction and demolition waste", Construction and Building Materials 43 (2013)497–505
2. Ajay Singh Jethoo, Harshwardhan .S.C et.al., "Evaluation of use of Kota Stone Mining Waste as Fine Aggregate in Bituminous Courses", International Journal of Engineering Technology, Management and Applied Sciences- May 2017, Volume 5, Issue 5, ISSN 2349-4476
3. ArunPratap Singh Rathore, Karan Parbhakar, "Soil Stabilization Using Kota Stone SlurryIn Pavement", International Journal of Innovative Research in Science, Engineering and Technology- Vol. 7, Issue 5, May 2018
4. Asi Ibrahim, Shalabi Faisal et.al. "Use of basalt in asphalt concrete mixes", Construction and Building Materials 23 (2009) 498–506
5. Dr. Bharat Nagar,Virendra Singh Shekhawat et.al., "USE OF MARBLE DUST AS FILLERS IN ASPHALT PAVEMENT", International Journal of Modern Trends in Engineering and Research (IJMTER)Volume 04, Issue 10, [October– 2017]
6. HuseyinAkbulut, CahitGurer," Use of aggregates produced from marble quarry waste in asphalt pavements" Building and Environment 42 (2007) 1921–1930
7. Ignacio Pérez, Ana R. Pasandín et.al. "Evaluation of steel slag coarse aggregate in hot mix asphalt concrete", Journal of Hazardous Materials 165 (2009) 300–305
8. Julian Mills-Beale, Zhanping You, "The mechanical properties of asphalt mixtures with Recycled Concrete Aggregates", Construction and Building Materials 24 (2010) 230–235
9. Mustafa Karasahin, SerdalTerzi, "Evaluation of marble waste dust in the mixture of asphaltic concrete", Construction and Building Materials 21 (2007) 616–620
10. MoghadasNejad, A.R. Azarhoosh et.al. "Laboratory evaluation of using of recycled marble aggregates on the mechanical properties of hot mix asphalt", Journal of Materials in Civil Engineering-2012
11. Olumide Moses Ogundipe, "Marshall stability and flow of lime-modified asphalt concrete", Transportation Research Procedia 14 (2016) 685 – 693
12. Pradeep Kumar Gautam, Dr. PawanKalla et.al, "Laboratory investigations on hot mix asphalt containing mining waste as aggregates" , Construction and Building Materials 168 (2018) 143–152
13. PawanKalla, Ravindra Nagar et.al, " Laboratory investigation on use of quarry waste in open graded friction course", Resources Policy-2018
14. ShaopengWua, JinjunZhong et.al, "Influence of demolition waste used as recycled aggregate on performance of asphalt mixture", Road Materials and Pavement Design-2013
15. Surender Singh, G.D. Ransinchung R.N. et.al. "Utilization of reclaimed asphalt pavement aggregates containing waste from Sugarcane Mill for production of concrete mixes", *Journal of Cleaner Production*- S0959-6526(17)32486-1
16. Specification for Road and Bridge Works- 5th Revision, Ministry of Road Transport & Highways.

BIOGRAPHIES

"Abhishek Mudgal is the M.Tech Scholar from Jaganath University, Jaipur"

"Nandeshwar Lata is Faculty in Civil Engg. Department of Jagannath University, He has 7 years of teaching experience."

"Dr. Bharat Nagar, Professor, Jagannath University is renowned academician and researcher having more than 40 publications and publication assistance."