

## An Experimental Study on Natural Material Replacement by Rap in Dense Bituminous Macadam (DBM)

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### ABSTRACT

Reusing of black-top asphalt in India is another rising innovation for road development. It was as is a common practice in India that the old weakened asphalt were crushed and their dumping is done in the landfills till now, it not even creates a huge amount of waste but also puts negative effect on surrounding environment and pollutes the land where the dumping of road waste has been done, In this manner squandering such potential material alongside putting unsafe effect on atmospheric condition. This can be reused afterward for development of novel asphalts and support of the more seasoned ones. While it has been considered as waste till now but some innovation and research has shown great potential of this waste to be used in re development of roads. Such innovation has gigantic potential that by itself 100 million tons of RAP produced in United States of America every year and around 80% of produced waste are utilized in asphalt development. Reusing of asphalt is one such method which can diminish cost and simultaneously can give better execution. Utilization of reused black-top asphalt (RAP) won't bring about cutting its expense however will likewise diminish the natural effect by diminishing the utilization of virgin material just as sparing vitality. Where as the virgin asphalt is more commonly used to develop new roads but the reclaimed black-top asphalt material can be used after proper treatment is given to it. This innovation of development bring about equivalent better then the virgin blend and increment the anticipation against disappointment due to rutting and weakness along these lines diminishing the asphalt thickness. Consequently inspecting hot black-top blends in with various extents running from 10% to half of RAP are performed. The Asphalt layers used in flexible pavements, which have been chosen to examine plausibility and execution are grade II dense bituminous macadam. Investigation of various blends has been performed by following MoRT&H rules. Marshall results shows that Rap material builds the asphalt quality till certain percent of substitution and decreases the development cost just as makes condition eco inviting. So, it is a cost effective and environmental friendly development method that can be implemented in future development of roads.

**Keywords;** Bitumen , **Recovered “Asphalt Pavement , DBM Layer**

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### I. INTRODUCTION

#### Problem Statement

Transportation system of any country is considered as their economical blood veins, and developing feasible transportation system is always a requisite for good development. Road transportation is one of best mode of transportations among all these modes of transportation, so to develop an economical and eco-friendly road transportation system is much needed now a days. Roads are the financial life saver for an evolutive nation like India and economical advancement is the way to future. In this way advancing toward it we need innovation that make development of asphalts financial just as which can exceed the regular one in execution alongside limiting the natural effect. Reusing of

asphalt is one such strategy which can diminish cost and simultaneously can give equivalent execution moreover.. In this manner the primary point of our undertaking is to check the attainability of reused asphalts for the development of provincial and urban streets also their restoration utilizing fluctuating extents of RAP in hot blend black-top and looking at it by different experiments. “The example of old asphalt was chosen from an longstanding rustic road going to be wrecked for the best possible development of the upgraded one.

#### Recovered“Asphalt Pavement

The term Recovered or reclaimed denotes that the asphalt that has been formed in past to develop any road is now no longer sustainable and

it has to be demolished, so to recover it or reclaim it, proper processing has to be done. The cleared and moreover reprocessed black-top materials containing asphalt with aggregates are denoted as Recovered black-top asphalt (RAP). At this site, The RAP is handled utilizing various steps progression of activities, inclusive screening, pulverizing, passing on, and stacking. Regardless of the way that the majority of bituminous asphalt is reused at central taking care of plants, bituminous asphalt may be beat setting up & united in granular or offset base courses using a self-moving pounding equipment. Hot & cold method of recycling methodology have formed into consistent train exercises that join fragmentary significance removal of the black-top surface, mixing recouped material that have beneficiating included matters, (as for instance, virgin aggregate, spread, or conceivably progressing or reestablishing administrators to improve latch property), and compacting and setting the result mix in a singular pass.

While setting up black-top reusing, this is particularly the circumstance. Three chief necessities must be satisfied for black-top asphalt reusing to become productive. Reused black-top asphalts must:

1. It ought to be savvy,
2. It ought to be naturally mindful, and
3. It additionally performs well.

#### Objectives of Study

- Making construction economical. So to reduce use of newer material.
- To collate physical properties of virgin aggregate with Reclaimed aggregate.
- Substitution of virgin material with Recyclable aggregate into DBM.
- To examine impact of RAP on DBM Layer of Flexible Pavement.
- To look-into the Strength and Stability parameter of different mix with the help of Marshall Test on DBM Layer of Flexible Pavement.

## II. LITERATURE REVIEW

There are numerous examinations directed by numerous researchers and designers who have been considered or taken in writing on the conduct and execution of bituminous asphalt ingredient as diverse waste/recyclable material, for example, recovered aggregates, wrecked waste, recovered bitumen, squander plastic, squander elastic, and more kind of worthless materials in different strata of adaptable asphalt by doing supplanting and/or including with virgin "aggregate" and regular bituminous material.

Monu Kumari et.al. (2018) examination advances the use of reclaimed material for evolutive nations as India. In India hot blend black-top is as yet very popular and well known used innovation. Thick Bituminous Macadam (DBM) blends were set up with various extents (half and full) of complete RAP (TR), and fine grade RAP (FR) and coarse grade RAP (CR) acquired from 2 distinct sources independently. The methodology was embraced inferable from the way that "uncontrolled processing" is as yet the major basically possible strategy for recovering RAP. Few quality and sturdiness properties have been taken in care while choosing the ideal extent of RAP material for making their use in DBM blends. It was discovered that CR blends request more amount of virgin black-top adhered by FR and TR blends to accomplishing the alluring properties of volume. It was found that TR blend have the most noteworthy Marshall Stability esteem while other of the blends could accomplish similar solidness esteem. Essentially, the rutting execution of all the blends was altogether higher than the control blend; be that as it may, FR blends demonstrated practically identical execution to TR blends. Then again, both the individual portions of RAP had equivalent dampness obstruction (rigidity proportion) to the control blend, while, complete division blends couldn't meet the base determined cutoff points. Indeed, even the scraped spot opposition in standard condition was more than the control blend of CR and FR blends. Weiying Wanga et.al. (2017) look into focus execution assessment of recycled/reused latches containing sublimate rate RAP conceal (to seventy percent) with combining of two sorts of WMA included substances, i.e., surfactant (MW) and polyethylene wax (RW). The Pressure "ageing vessel (PAV) and rolling slim film oven "(RTFO) was used to acquired artificial RAP and developing is done to ensure its unadulterated source and known properties. To check the properties of reused folios, The beams bendings rheometer (BBR), dynamic shear rheometer (DSR) and rotational viscometer (RV) tests were done. At some random test temperature higher consistency have been achieved at higher RAP content. The joining of the WMA added substance RW diminished the consistency amazingly, while the thickness of RAP-MW fastener changed somewhat in contrast with the managed reused cover. In such manner, the level of RAP folio could increment by WMA innovation. It is suggested that further the development work ought to be led on the examination of RAP folio extricated from various sources like wellsprings of processing asphalt and comparison should be done with the counterfeit RAP cover. Besides, it is

important to do some concoction tests and research to portray the properties from full scale and miniaturized scale scales individually. 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.

**Material Used**

A decent and viable undertaking/research can be done by choosing crude material as per appropriateness and accessibility in neighborhood areas. In this venture work different sorts of materials utilized are depicted as follows:

- A. Bituminous material
- B. Aggregates (fresh and reclaimed both).

**Table 1 Dense Bituminous Macadam Mixing Details and designation**

Designation	Natural Aggregate (%)	RAP (%)
<b>RAP0</b>	100	0
<b>RAP10</b>	90	10
<b>RAP20</b>	80	20
<b>RAP30</b>	70	30
<b>RAP40</b>	60	40
<b>RAP50</b>	50	50

**III. METHODOLOGY**

Different mixes are to be featured with the Marshall test to examine out the binder content value that is optimum and at which achievement of maximum stability cognized. For both the DBM Layers at different mixes, Marshall Test is performed on gradation.

Binder content shouldn't be less than 4.5 % of total mass as per the specification of MoRT&H. For flexible pavement the BM is

considered as surface coarse. Binder percentage is taken at different intervals initially it is taken 4 and on a broader state 6.5 percentis taken and the interval kept between various blend of mixes is 0.5 percent in order to evaluate optimum binder content value with taking help of Marshall Test. The outcomes of Marshall Mix examination done at different values of the binder content values for different mixes are under mentioned:



**Fig 1 Mixing material for Marshall Specimen**



Fig 2 Marshall Specimen



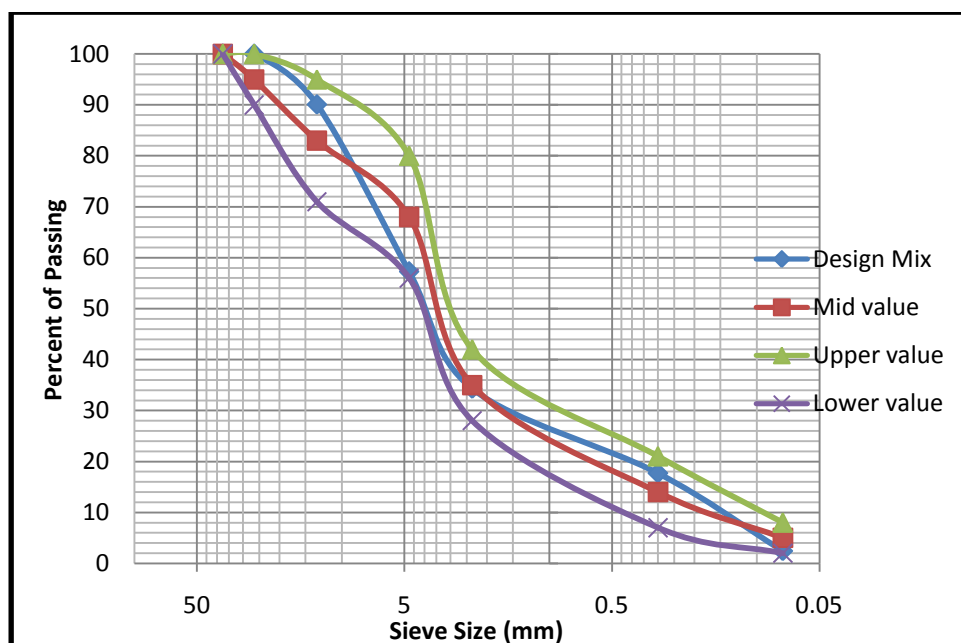
Fig 3 Weighing sample in air and water

#### IV. RESULTS & DISCUSSIONS

Table 2 DBM II Mix Gradation

Proportion Kept for mix	Percentage of passing (in %)				Mix for trial (in %)				Cumulative	Recommended of MoRTH	
	100	100	100	100	10	30	35	25			
Size of sieve (in mm)	20	10	6	filler	20	10	6	filler	100%	Specimen	GH

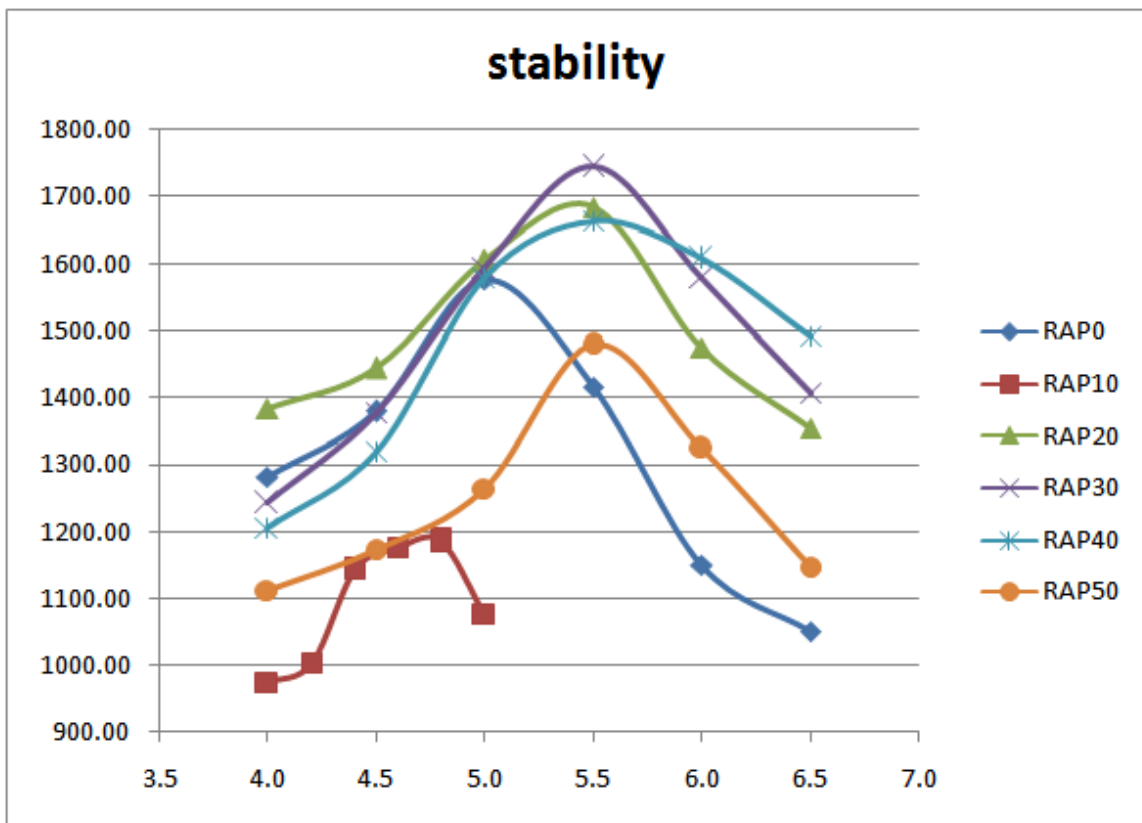
37.5	100	100	100	100	10	30	35	25	100	100
26.5	100	100	100	100	10	30	35	25	100.0	90-100
13.2	34	89	100	100	3.4	26.7	35	25	90.1	71-95
4.75	9	19.2	73	100	0.9	5.76	25.6	25	57.2	56-80
2.36	4	5.2	21	100	0.40	1.56	7.35	25	34.3	28-42
0.3	0	2.4	2.8	64	0.0	0.72	0.98	16	17.7	7-21
0.075	0	0.6	1.6	6.8	0.0	0.18	0.56	1.7	2.4	2-8



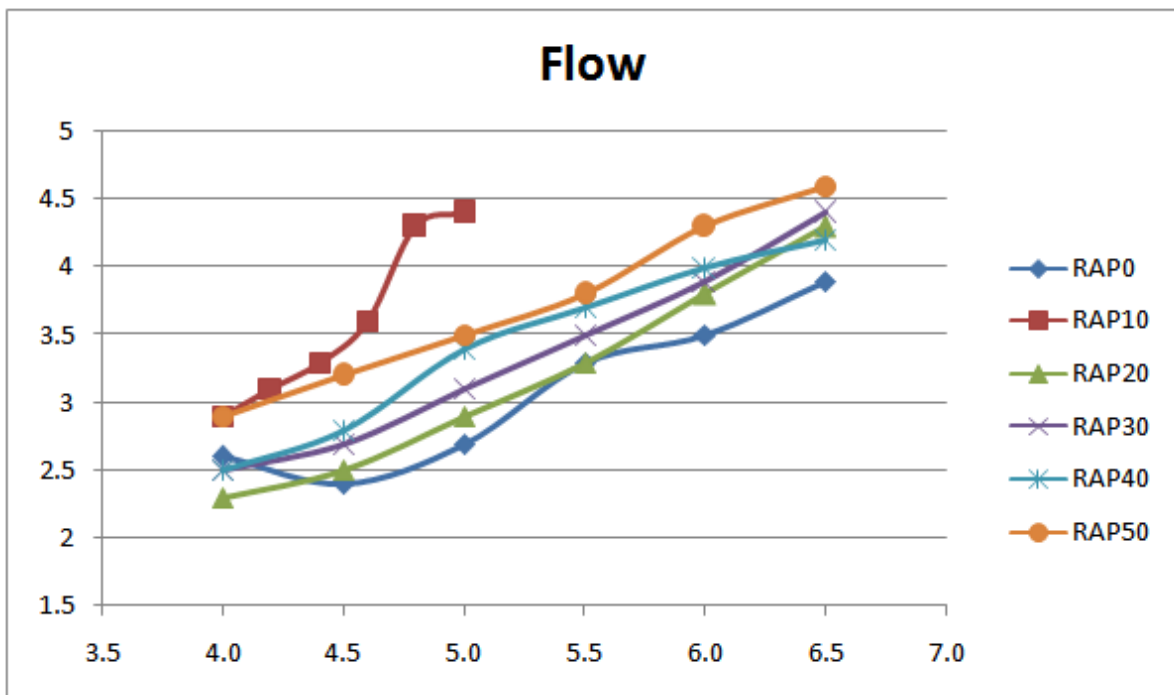
Graph 1 DBM II Mix Gradation



Fig 4 Sieve shaker Apparatus with sieves



Graph 2 comparison for DBM layer Marshall Stability using differ bitumen quantity



Graph 3 comparison for DBM layer Marshall flow using differ bitumen quantity

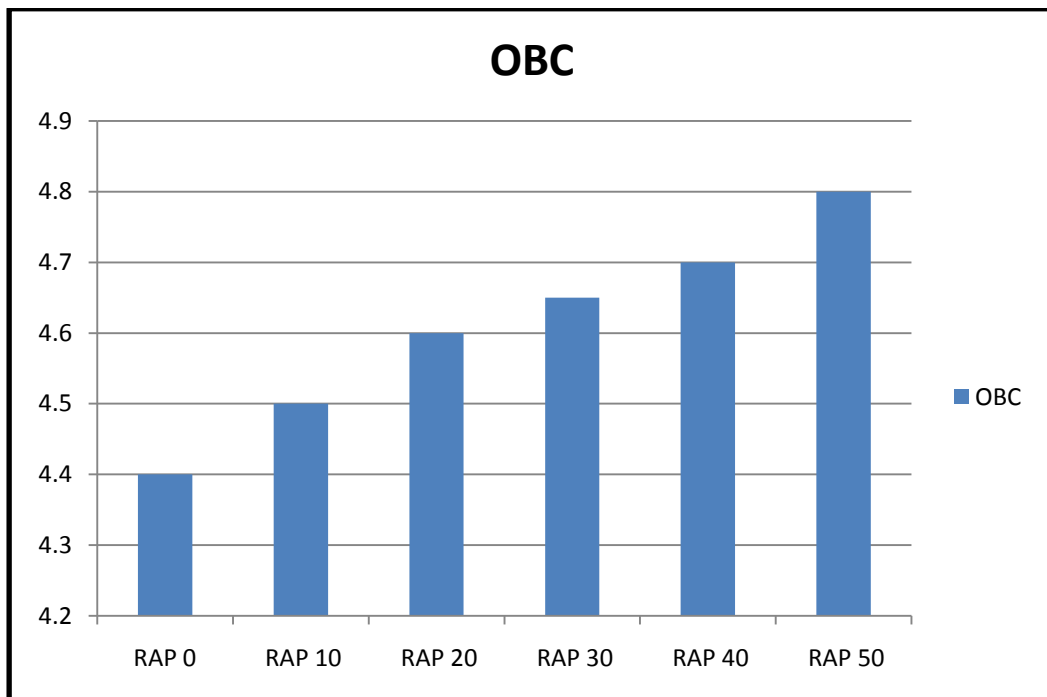


Fig 4.26 OBC Comparison for DBM layer of differ mixes

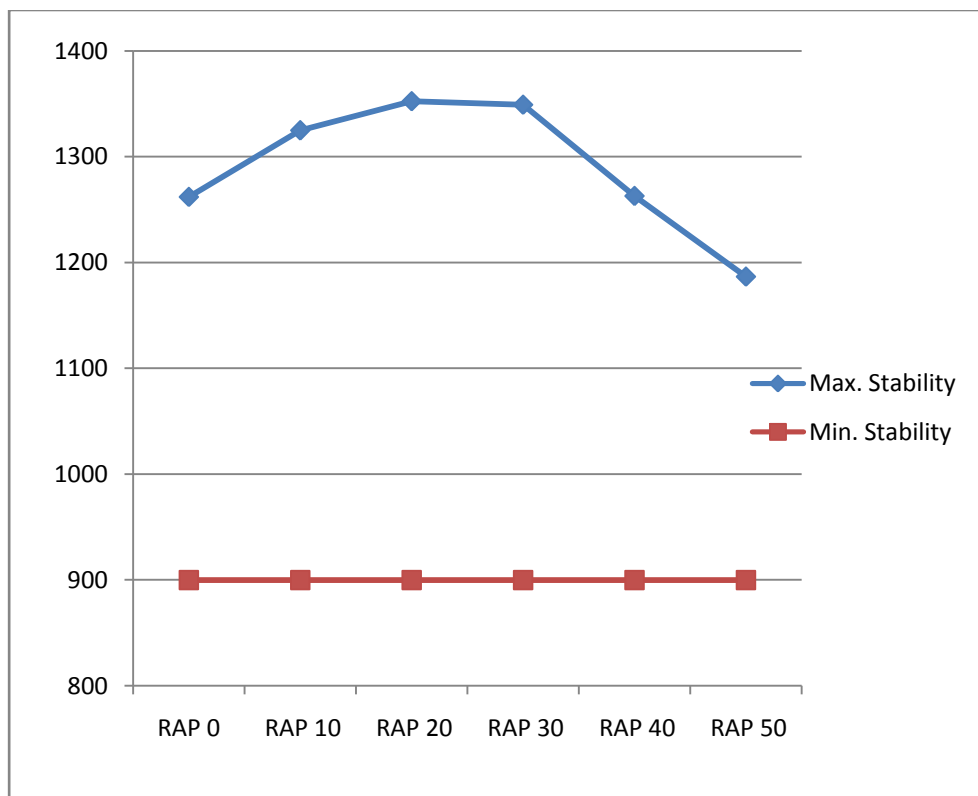
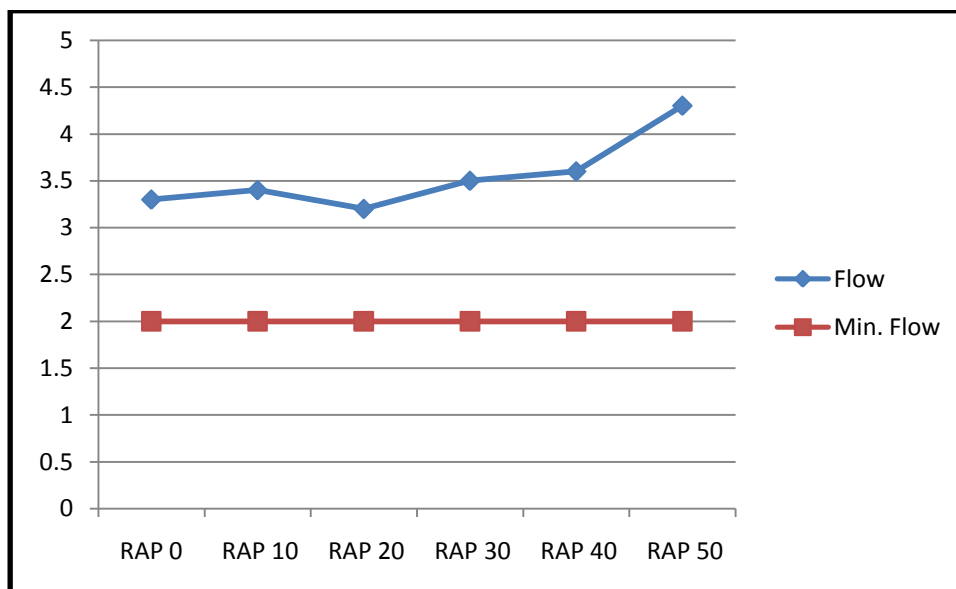
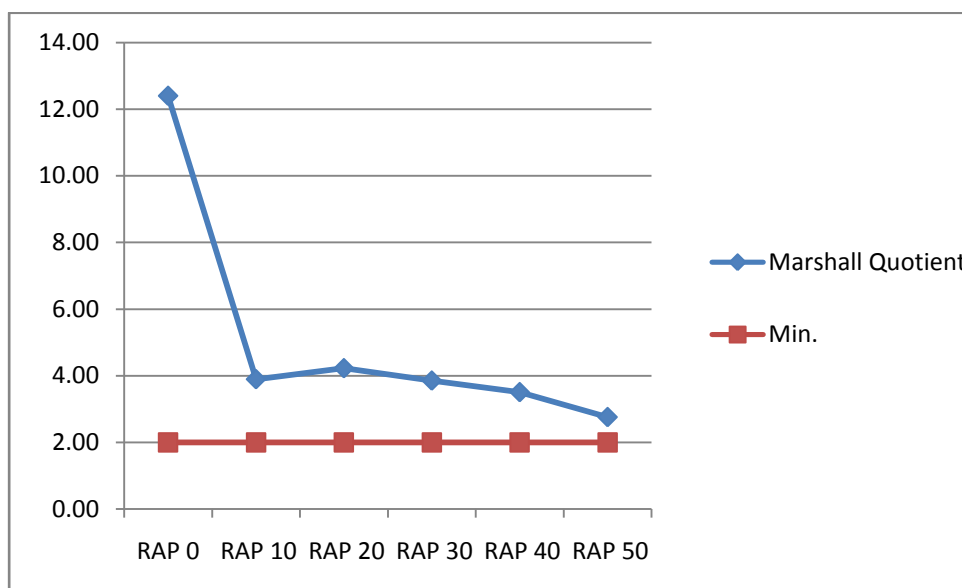


Fig 5 Max stability Comparison for DBM layer of differ mixes



**Fig 6 Flow Comparison for DBM layer of differ mixes**



**Fig 7 Marshall Quotient Comparison for DBM layer of differ mixes**

## V. CONCLUSION

- ❖ It has been observed that up to replacement of 30% the Marshall stability of reclaimed or recovered aggregate were found increasing than the Marshall stability of convention mixes. And when 20 % replacement was made than it showed maximum strength.
- ❖ The above result analysis shows that 20% replacement has shown optimum strength and stability value, along with this it uses less natural material, making development eco-friendly.
- ❖ The doses of Binder content (optimum) varied at different mixes, The maximum value found at 20 % replacement.

- ❖ Total saving of 38699 has been seen for 20 % replacement.

## 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]. Asi Ibrahim, Shalabi Faisal et.al. “Use of basalt in asphalt concrete mixes”, *Construction and Building Materials* 23 (2009) 498–506
- [3]. Huseyin Akbulut, Cahit Gurer,” Use of aggregates produced from marble quarry



- waste in asphalt pavements” *Building and Environment* 42 (2007) 1921–1930
- [4]. 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
- [5]. Julian Mills-Beale, Zhanping You, “The mechanical properties of asphalt mixtures with Recycled Concrete Aggregates”, *Construction and Building Materials* 24 (2010) 230–235
- [6]. Shaopeng Wua, Jinjun Zhong et.al, “Influence of demolition waste used as recycled aggregate on performance of asphalt mixture”, *Road Materials and Pavement Design*- 2013
- [7]. 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
- [8]. Shubham Bansal, Anil Kumar Misra, Purnima Bajpai “Evaluation of modified bituminous concrete mix developed using rubber and plastic waste materials”, *International Journal of Sustainable Built Environment* (2017) 6, 442–448
- [9]. Johnson Kwabena Appiah, Victor Nana Berko-Boateng, Trinity Ama Tagbor, “Use of waste plastic materials for road construction in Ghana”, *Case Studies in Construction Materials* 6 (2017) 1–7
- [10]. D. Movilla-Quesada, A.C. Raposeiras et.al., “Use of plastic scrap in asphalt mixtures added by dry method as a partial substitute for bitumen”, *Waste Management* 87 (2019) 751–760
- [11]. Sara Fernandes, Liliana Costa et.al. , “Effect of incorporating different waste materials in bitumen” *Ciência & Tecnologia dos Materiais* 29 (2017) e204–e209
- [12]. Monu Kumari, G.D.R.N. Ransinchung, Surender Singh, “A laboratory investigation on Dense Bituminous Macadam containing different fractions of coarse and fine RAP” , *Construction and Building Materials* 191 (2018) 655–666
- [13]. Weiyang Wang, Jingyun Chen et.al. , “Laboratory performance analysis of high percentage artificial RAP binder with WMA additives”, *Construction and Building Materials* 147 (2017) 58–65
- [14]. Bindu C. S, Dr. K.S. Beena, “Waste plastic as a stabilizing additive in Stone Mastic Asphalt” *International Journal of Engineering and Technology* Vol.2 (6), 2010, 379-38
- [15]. N. Guo, Z. You, Y. Zhao, Y. Tan, A. Diab, Laboratory performance of warm mix asphalt containing recycled asphalt mixtures, *Constr. Build. Mater.* 64 (2014) 141–149.
- [16]. T. Ma, H. Wang, Y. Zhao, et al., Laboratory investigation on residual strength of reclaimed asphalt mixture for cold mix recycling, *Int. J. Pavement Res. Technol.* 8 (2015) 17–22.
- [17]. L. Gungat, N.I.M. Yusoff, M.O. Hamzah, Effects of RH-WMA additive on rheological properties of high amount reclaimed asphalt binders, *Constr. Build. Mater.* 114 (2016) 665–672
- [18]. X. Shu, B. Huang, D. Vukosavljevic, Laboratory evaluation of fatigue characteristics of recycled asphalt mixture, *Constr. Build. Mater.* 22 (7) (2008) 1323–1330.
- [19]. B. Huang, X. Shu, D. Vukosavljevic, Laboratory investigation of cracking resistance of hot-mix asphalt field mixtures containing screened reclaimed asphalt pavement, *J. Mater. Civ. Eng.* 23 (11) (2011) 1535–1543.
- [20]. IRC: SP: 98-2013. ”Guideline for the Use of Waste Plastic in Hot Bituminous Mixes (Dry Process) in Wearing Courses”. Indian Road Congress
- [21]. Specification for Road and Bridge Works- 5<sup>th</sup> Revision, Ministry of Road Transport & Highways.

Kapil Rana, et. al. “An Experimental Study on Natural Material Replacement by Rap in Dense Bituminous Macadam (DBM).” *International Journal of Engineering Research and Applications (IJERA)*, vol.10 (08), 2020, pp 15-23.