EFFECTIVE UTILIZATION OF RECLAIMED ASPHALT PAVEMENT (RAP) & RISE HUSK ASH IN BC MIX

PRE-DISSERTATION REPORT

Submitted by

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IN

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Under the guidance of

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DECLARATION

I hereby declare that the Dissertation report titled **"Effective Utilization of Reclaimed Asphalt Pavement And Rice Husk Ash in BC Layer." is** an authentic record of my own research work carried out as a requirement for the preparation of M. Tech. dissertation for the award of Masters of Technology Degree in Transportation Engineering from Lovely Professional University, Phagwara, Punjab under the guidance of Mr. Sai Kiran Varma during the period between August 2017 to December 2017. All the info provided in this report is based upon my concentrated hard work and is completely honest to the better of knowledge. And no part of these work in this report has ever been published before in any journal or presented for the award of degree or honors.

Date: 30-11-2017

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CERTIFICATE

This is to certify that **Y. V. PRUDHVI RAJU** under Registration No. **11610671** has prepared the dissertation-1 report titled "**EFFECTIVE UTILIZATION OF RECLAIMED ASPHALT PAVEMENT (RAP) AND RICE HUSK ASH (RHA) IN BC LAYER**" under my direction. This is a bonafide work of the above competitor and has been submitted to me in fractional satisfaction of the prerequisite for the honour of Masters of Technology in Civil Engineering.

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Y.V.PRUDHVI RAJU

SIGNATURE OF STUDENT

ABSTRACT

Recovered Asphalt Pavement (RAP) is an Innovative Technique in the current days. The utilization of waste materials alongside regular assets is outstanding amongst other approach. The reusing practice the material from compounded asphalt is called as Reclaimed Asphalt Pavement (RAP) is mostly or completely reused in new development. By this reused blend odds of breaking are observed to be less. In this way by this exploration demonstrates that few Of RAP extents are to be utilized as a part of the development of bituminous mixes shifting from 0 to 100%. And furthermore supplanting the Rice Husk Ash as filler material in the outlined example with an extent of 5%. By this consolidated blend the aggregate cost of development will be decrease, better nature of blend by utilizing reused materials too positive effect on condition and shortage of waste items also. And examination the RAP physical property and used in adaptable asphalt as a Coarse& Fine total. The use of Rice Husk Ash (RHA) in the bituminous mix as a substitution of Oakum. To building up the properties of BC blend and making appropriate for Road developments. To explore the Strength of Bituminous blend by utilizing different extents of RAP and RHA by Marshall Test.

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INTODUCTION

1.1 BACKGROUND

1.1.1 RECLAIMED ASPHALT PAVEMENT (RAP)

Reclaimed Asphalt Pavement (RAP) is an Innovative Practice in India. It is a material which is obtained from the Demolished of road pavement. The use of waste materials along with natural resources is one of the best approach. The recycling practice the material from worsened pavement is called as Reclaimed Asphalt Pavement (RAP) is partially or fully recycled in innovative structure. By this recycled mix chances of cracking are found to be less. Therefore so many research shows that several Of RAP proportions are to be uses in the construction of asphalt pavement variable from 10-70% .Some exceptional cases using up to 80% of RAP has been fruitfully utilize in mixes. It is additionally reported that recycled mix has having higher strength to scuffing and shearing off that is turn to increase the rutting resistance. Using of RAP is reduces the cost of construction as well.

Recent days In India, The technique of RAP is using gradually implementing for roadway system. In India demolished road pavements are near about 8.5 tons per year producing by the roads. By this technique of the construction cost will be minimizing as well scarcity of waste materials and eco-friendly too.

The determination of utilizing RAP is more acceptable as from the previous few experiences that has been observed that strength of mix either of same or well quality to be made by RAP mixes as related to fresh mixes. The saving cost of construction is relative to the proportion of RAP used in the mix. A perfect percentage would be investigated which provides the ideal strength and economic as well.

The total scenario of RAP is to reduce the construction cost and scarcity of waste materials and it satisfies the mix with their properties of RAP as well, by utilizing these materials a new bituminous mix will be developing. Earlier researches are found out several proportion with various quantities and adding some admixtures to increase strength and stability of mix and also economically feasible.

Figure 1.1 Reclaimed Asphalt Pavement

Development of recent days various technologies was invariably targeted on increase cost-effectiveness, however recently beside economic effects and environmental problems are assumed about, like decreasing the harmful influence on the atmosphere within the production of material and execution of works. Defining the most effectively use of rap technique is predicted on an arrangement of field and theoretic studies.

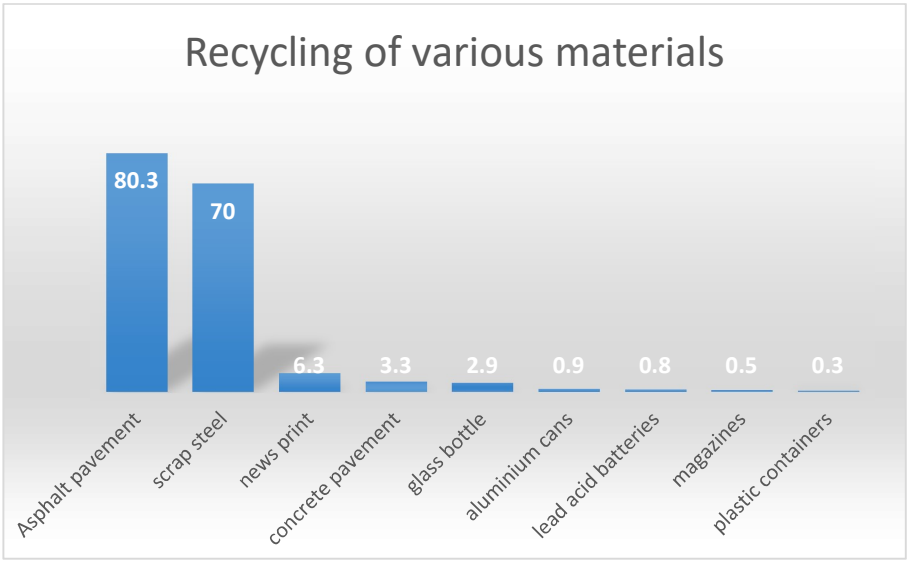


Figure 1.2 USE OF RAP

1.1.2 RICE HUSK ASH

Rice Husk Ash (RHS) is a by-product from the scorching of Rice husk. Rice milling industries are generating plenty of Rice Husk Ash (RHS) in every year 170 million tones are produces by the industries all over the world. In India, rice husk is produced in larger quantities, and it is approximately 18-22 million tons. The RHS usual used as fuel for power generation and these corresponds to power generation of 1200MV. The power generation utilizing rice husk is exceptionally efficient in India because of high accessibility of rice husk in our nation. Rice husk is one of the main cultivating stores accomplished from the outside shell of rice grains amid the refining procedure. It sets up 20% of the 500 million tons of paddy framed on the planet. . There are few rice husk based power plants in India which has a capacity of 1-10MV are already in operation. These rice husk power plant are based on direct consumption or fluidized bed consumption plants.

Nowadays, expanding of centre in the utilization of waste materials. On account of creation industry there was a rising pattern towards the advancement and use of waste as extra of bituminous assets. The agribusiness side-effects, for example, fly cinder and RHA are complimenting dynamic zones of research since not exclusively do their utilization prompts differentiated item nature of the blended Bituminous blend , yet additionally prompts the lessening in cost and negative ecological impacts also. It is meant to expand the execution and life expectancy of streets by utilizing different option assets.

Figure 1.1 Rice Husk Ash

1.2 OBJECTIVES OF THE INVESTIGATION

- To investigation the RAP physical property and utilized in flexible pavement as a Coarse& Fine aggregate.
- To Investigation the utilization of Rice Husk Ash (RHA) in the bituminous blend as a replacement of Oakum.
- To checking possibility of using more RAP along with natural aggregate.
- To investigate the Strength of Bituminous mix by using various proportions of RAP and RHA by Marshall Test.
- To developing the properties of BC mix and making suitable for Road constructions.

1.3 NEED OF STUDY

- More Accessible and solve to disposal problem of RAP.
- Satisfy the scarcity of natural materials.
- It reduces the cost of the construction as well.
- Recycling the waste products by the basis of Environmental safety.
- Cost of construction will be minimizing instead of using these materials.
- By this materials BC mix will be having either of same or well quality are to be formed by RAP blends as compared to Conventional blends.
- Economically Feasible and Eco friendly.

1.4 SCOPE OF THE INVESTIGATION

- Apart from 100,75,50,25 other percentages of RAP material can also be used determine stability.
- Apart from Rice husk ash material can also replace the filler in design mix, (ex: Fly ash, Cement, Marble dust, stone dust, etc.)
- Effective use of RAP content which gives more cost effectives and strength.

CHAPTER-2

LITERATURE REVIEW

1. Saurabh S Mahankali, Satish R Patel, Vishal A Patil (23rd March 2016).

- R.A.P is a developing framework in India, and the use of R.A.P is dynamically expanding the appreciation consistently. Utilizing R.A.P isn't just valuable to lessening the financial plan of development yet additionally guarantees the proper utilization of material.
- The target of this examination is to fathom the quality of utilizing RAP for the development of black-top asphalt. This exploration and the prior examines can be inferred that utilizing RAP is advantageous. What's more, these blends can deliver yield comes about either equal or significantly more prominent than the new blends.
- If consider and presented reasonably R.A.P blends constructively affect a different constraints like Marshall Stability, Moisture protection and thickness with respect to RAP.
- It allows the likelihood of usage R.A.P blends with a parameters of 10-70% RAP utilized.

2. M.A. Lyubarskayaa, V.S. Merkushevab (19 May 2017).

- This researcher investigates that the lack of problem are to be facing in the system approach to using R.A.P techniques.
- The determination of this study is to evaluation the global experience with RAP, identify the communal matters of execution of this new technique and cultivate methods to be ensure a multi variant approach to the use of R.A.P.
- The technique of selecting a scheme of application RAP technique should reports two leading issues: (1) Price efficiency and (2) Decreasing the harmful influence on the atmosphere.
- It responsible the best active use of R.A.P technology is founded on the arrangement of field and abstract studies.

3. Luca Noferini, Andrea Simone 29 March 2017.

- In this research, the most recent surveys are to be announced the European area produced 265 mil tonnes of asphalt for road applications in 2014. In the same year, the amount of available RAP was more than 50 mil tonnes are produced.
- The practice of R.A.P in innovative blended mixes reduces the need of Virgin bitumen, making RAP recycling economically attractive and can be recycling the products.

- Despite the economic and environmental benefits, road authorities are tended to limit the use of RAP in asphalt mixes due to uncertainty about the field performances of RAP.
- The present study focuses on the interaction between fresh and RAP bitumen in asphalt mixes made with different RAP content. The effects of RAP on physical and rheological properties of the final bituminous mix were investigated.
- This study is part of a wider research, where a specific type of asphalt mixture was produced with different RAP contents being 10%, 20% and 30% by the weight of the mix.
- Bitumen was extracted and recovered from asphalt mixes, then it was subjected to the following laboratory tests: standard characterization, dynamic viscosity and rheological analysis. Findings showed that the effects of RAP bitumen on the final mix varied in proportion to RAP content.
- A threshold value of RAP content was found, below which bitumen was not subjected to significant changes in physical and rheological properties. Practical implications on production methods and paving of RAP mixes are also proposed.

4. Muhammad Arshad, Muhammad Farooq Ahmed 17 May 2017.

- In current road and pavement engineering practices, the lack of fresh natural aggregate (granular material) supplies with increasing processing costs have led to use various reclaimed/recycled materials from old structures as a source of construction materials.
- Reused Concrete Aggregate (RCA), Reclaimed Asphalt Pavement (RAP) have been reused as totals for asphalt development for quite a while
- This study is focused on the characterization of blended materials containing 50% and 75% of RAP with fresh granular materials and RCA to evaluate whether they are suitable for granular base/subbase layers of flexible pavements.
- A series of laboratory tests was performed to determine the resilient modulus (MR) and the constrained modulus (Mc) for both fresh granular materials and their blends. Statistically, the notable increase was found in the MR values of the mixed samples containing the 75% RAP material and 25% fresh granular, particularly at higher levels of bulk stresses.
- It was also found that the accumulative strains during cyclic loading generally rise with a growth in the percentage of R.A.P contents in the blended samples. Mc test results show an increasing trend with the increasing level of axial stress, however, Mc value decreases with increasing percentage of the RAP content. Never-the-less, the t-test showed that accumulative strains during Mc tests were found to increase significantly with an increase in the percentage of RAP contents.

5. Dony , J. Colin , D. Bruneau 22 November 2012.

- For natural wellbeing and to direct costs, bituminous solid creation coordinates recovered/reused materials from the wrecked of street overlays under rebuilding in a system ponder absolutely to abbreviate the act of new materials.
- While the reutilizing recurrence is more, it is expected to control the properties of a definitive folio to affirmation the exhibitions of the recovered black-top totals.
- The target of the present investigation was to think the rheological highlights of the crisp bitumen and the class of reviving operator it contained and their impact on the current and rheological highlights of a definitive folio.
- The recovered black-top asphalt fastener reused in a few tests was first all-around characterized seeing someone of it unwavering quality and rheology.
- The result of matured on these extreme fasteners in the succession of creation and all through the age of the black-top cement out and about was imagine tentatively by the Rolling Thin Film Oven Test and the Pressure Aging Vessel method.
- A rheological investigation of the considerable number of covers was then acknowledged by utilizing obsolete run of the mill examinations, and in including an absolutely adjusted exploratory strategy was utilized to assess the execution of the item at a few compelling temperatures.

6. Mahyar Arabani , Seyed Amid Tahami 12 May 2017.

- Using rice husk ash (RHA), as a waste by produce of rice milling, in bituminous roadways provides a valuable advantages such as reduction of environmental degradation, lowering construction costs and saving natural resources.
- However, there are limited numbers of studies on application of this material in asphalt mixture.
- The goal of this type learning is to investigate the properties of Rice Husk Ash as a bituminous modifier on hot mix asphalt.
- Bitumen mixes with 5%, 10%, 15% and 20% RHA modifier are to be checked. For costing of the rheological properties of bituminous binders and various tests to be containing penetration grade, ductility, softening point were conducted. Also, the mechanical properties of asphalt mixtures including Marshall Stability.

- The outcomes showed the rheological assets of bitumen was upgraded by adding RHA. Also, RHA modification ensured positive impacts on the Marshall Stability, stiffness modulus, rutting strength and fatigue act of asphalt mixtures.

7. Sebbnem Sargın, Mehmet Saltan, Nihat Morova". "17 June 2013".

- In this amendment, it was investigated to use the Rice husk powder (RHA) in the black-top mix as a filler material.
- For this reason, the four modified of extents black-top solid trials were created utilizing as a part of a few extents are specified 4, 5, 6, and 7 rates as latent filler.
- The amount of perfect bitumen and the rate of Marshall Stability (MS) were firm with Marshall Test for the cases.
- Selecting the arrangements of bitumen having 5 percent filler which has indicated the most extreme quality RHA was changed with Lime Stone filler in the extent of 25, 50, 75, and 100 rates.
- Afterwards Marshall Stability test was performed for the required specimens and the results were evaluated. As a result, it has come in supposition that R.H.A can be use as an inactive filler in the bitumen blend.

8. Sireesh Saride, Deepti Avirneni, Saratha Chandra Prasad Javvadi.

- Use of RAP in the construction department is acquisition an advantage over than the conventional mixes in terms of justifiable tributes. Though, the quantity of generating of RAP and its consumption has not any contrast in the field.
- In this study, the broad practices is to substitute a minor portion of fresh aggregates with RAP is regularly classified to an extreme of 30% in base deposits to stimulate RAP practise in the asphalt production.
- The current study emphases on the use of a more quantity of R.A.P greater than 50% replacement in fresh aggregates (FA) as a base layer material in low volume roads (LVR). Blends comprising 100, 80, and 60 percentages of R.A.P fulfils through an altered proportions of fly ash were calculated for a Maximum Dry Density (MDD) , optimum moisture content (OMC), California bearing ratio (CBR) of given material to be recorded.
- The outcomes exposed that the exhaustion and rutting strains are well within the allowable parameters for the fresh mix. The fresh blend intention verified efficient and reasonable stability as well, as around 50% decrease in base coat thickness related to the conventional design mix.

9. Surendher Singh , G.D. Ransinchung , Praveen Kumar (5 May 2017).

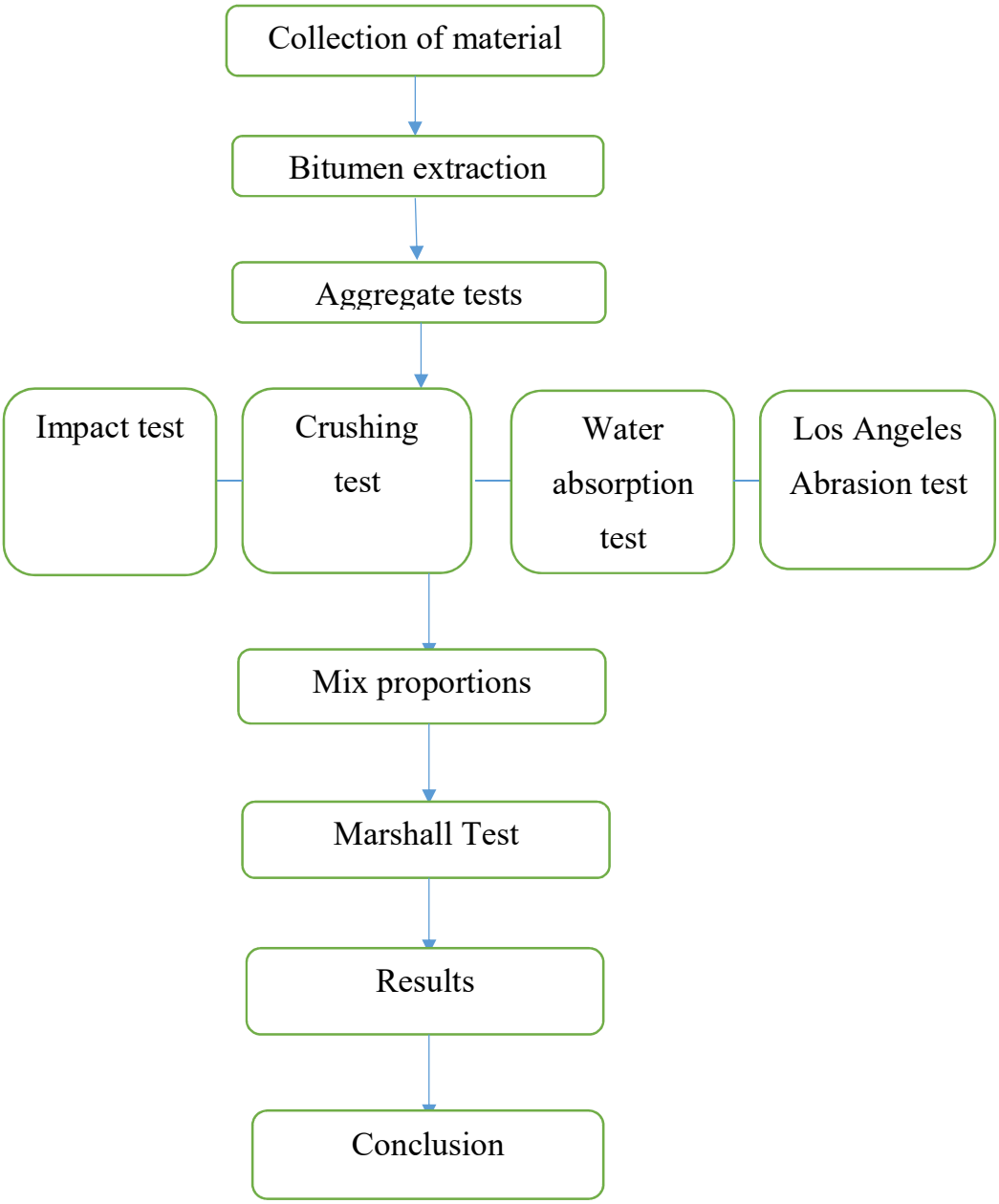
- In this examination, black-top blend around Reclaimed Asphalt Pavement (R.A.P) totals is being conveyed as the primary viewpoint dropping the properties of R.A.P extensive cement.
- A creative Attrition and Abrasion practice to propel the nature of R.A.P by disposing of the contamination layers of tidy and puncturing the black-top seeing to R.A.P totals is presented in this examination.
- The impact of incorporating Washed R.A.P (WRAP) and Dirty R.A.P (DRAP), treated R.A.P, on the new, solidness and mechanical properties of cement are likewise contemplated and connected with each other.
- The mechanized properties of R.A.P totals were observed to be better altogether on preparing with AB
- Benefit of R.A.P by AT and AB strategies are enhanced the compressive quality of blend by 9.73% and 12.72%, split malleable by 2.67% and 12.22% rates and flexural quality by 6.05% and 8.55% as identified with DRAP and WRAP far reaching blend. Mix of R.A.P into black-top mix improved cohesiveness and workability. Effective assets of asphalt such as primary rate of water immersion, water absorption, entire pervious cavities and co-efficient of water raptness were practical to be decrease for Reclaimed Asphalt Pavement.

10. Rajeev Chandra, A. Veeraragavan 2013

- The major aspect of this study is to estimate the use of two blend designed techniques for design asphalt pavement blends with foamed asphalt. Mixed proposal was approved resulting the Caltrans and South African guiding principle.
- The R.A.P resources are to be used for blend policy were composed from the NH-5, Chennai-Tada sector. By means of foamed asphalt formed from Wirtgen 10 foaming apparatus, a mixture with R.A.P content, fresh aggregate and dynamic filler material were formed in the Mixing Mill.
- Marshall Compact strength is too used for the formulating the specimens. Using the secondary tensile strength test on wet and dry samples, the ideal binder content will be recorded. It seems that the two blend intention were procedure accepted to present the altered blend components although exhausting the same RAP material.

CHAPTER-3

METHODOLOGY



EXPERIMENTS

TESTS ARE TO BE PERFORMED:

To regarding this project tests are to be conducted, As per IRC 94-1986 DBM specification have mentioned several requirements to satisfies the mix design. It shall be consists of coarse, fine aggregates and filler in a suitable proportions with required of binder content.

4.1 BITUMEN EXTRACTION TEST :(RAP)

I.R.C-S.P 11-1988, ASTM D 2172

Need of Test:

Bitumen Extraction test is to govern the bitumen content in the bituminous mix by the solvent removal. Regarding this test the aggregate and binder content will be divide.

Figure 4.1 Bitumen extractor

Apparatus:

- Automatic Electrical Centrifuge.
- The Balance of capacity 1200 grams and sensitivity is 0.01 grams.
- Thermostatically controlled kiln with capacity up to 250℃ and with speed of 3600 rpm
- Bowl for collecting the Extracted material.

Procedure:

- Firstly, Pre heat the material for easy handling the sample.
- Take accurately 1200 gm of example and keep into a basin of extractor tool (w_1).
- Enhance benzene to sample material till that entirely immersed.
- Parched and Weight the sieve paper and keep it over the bowl of the extraction tool comprising the sample (F_1).
- Fix the shield plate securely.
- Keep a mug below the drain pipe to the gather the bitumen waste.
- Adequate time is allowed for the dissolvable to part the specimen before running the axis.
- Run the rotator gradually and the step by step increment the speed to a most extreme of 3600 RPM.
- Run centrifuge until asphalt & benzene are rainout fully.

- Stopover the instrument, expel the cover plate and add more benzene to the example in extraction is done in an indistinguishable procedure from portrayed.
- Reiteration the similar procedure not > 1 time till the abstraction is pure and not in dimmer than a bright hay in colour.
- Gather the material from the bowl of the extraction machine alongside the channel paper and dry it to consistent weight in the oven warm at high temperature of 1050 ℃ - 1100 ℃ and after quiet to at room temperature.
- Measure the material (W2) and the channel paper (F2) independently to an exactness of 0.01grams.

CALCULATION:

Percentage of Bitumen in the overall mix $= \left[\frac{W1-(W2+W3)}{W1}\right] \times 100$

Where, w_1= weight of sample taken before extraction.

w_2= weigh the sample after extraction.

w_3= Differenced weight of filter paper (F_2-F_1).

Table 4.1 Calculation of Bitumen extraction Test

Type Of Material Tested	A Wt. Before extraction	B Wt. After extraction	C Diff. Grams (A-B)	D Total ash in mix (Frol L)	E Bitumen in Mix Grams (C-D-F)	% Bitumen in mix $E/Ax \times 100$

(Per Paper Over Dried)					ASH CORRECTION
Wt. Before Extraction	Wt. After Extraction	F Wt. Diff Grms	Wt. of Crucible &Ash Grams	G Wt. of Ash per100cc	L Wt. of Ash on total Solution- $\frac{G}{100} \times$ (Total. Sol)

Measure total bitumen Solution in C.C record total solution —C.C

Take 100 C.C from total solution for Correction

WEIGHT AFTER WASHED(GMS)							
WASH GRADATION EXTRACTED AGGREGATE							
Sieve Size							
Wt. Retained							
% Retained							
Cum% Retained							
% Passing							
Limits							

Report:

The outcome gained intend to be described by means of the proportion of bitumen contented in the mixture to nearby additional fraction.

4.2. AGGREGATES TESTINGS (RAP):

4.2.1 AGGREGATE IMPACT VALUE TEST:

Impact aggregate test is conceded to test the resistance to impact on the aggregate. It is calculated due to repeated impact load of wheels of vehicles on the pavement. The Impact test is standardized on IS: 2386 part-4.

Procedure:

Sieve sample of 12.5mm passing and 10mm retaining aggregate is to be collected and note down the weight.

- Fill the aggregated in the cylindrical mould within three layers (1/3, 2/3, 3/3).
- Each layers is tamped 25 gentle blows with using of tamping rod.
- Determine the weight of cylinder along with aggregate.
- Bring the impact loading machine to a rest position. Fix the cup firmly on the base plate of Impact apparatus.
- Rise the hammer about 380mm from the bottom of the plate and fall freely on the sample.
- 25 blows of free fall is repeated and weight the percentage of passing from 2.36mm sieve.

Figure 4.1 Impact Test

$$\textbf{Aggregate Impact Value} = \left(\frac{W2}{W1}\right) \times 100$$

Table 4.2 Aggregate Impact Values

S. NO	Type of pavement layer	Agg. value not extra than
1.	wearing Coarse	30
2.	Bitumen surface dressing	30
3.	Bituminous concrete	30
4.	C.C	30
5.	Bitumen bound macadam base coarse	35
6.	Water bounding macadam	40
7.	Cement Concrete Base Coarse	45

4.2.2 AGGREGATE CRUSHING VALUE TEST:

Crushing test is used to evaluate the quality of aggregate by applying crushing load gradually. The crushing test is standardized on IS: 2386 part-4.

Procedure:

- Take a sample of aggregate and sieve analysis is carried out.
- Take a sample which is passing through 12.5mm sieve and retaining from 10mm sieve.
- Cylindrical mould which has 11.5cm diameter and 18cm height.
- Cylindrical mould is filled within three layers and using gently 25 blows with tamping rod on each layers.
- The sample is exposed to compressive load of 40 tones, progressively 4 tones/minute.
- Crushed aggregates are to be sieved from 2.36mm sieve and percentage passing is weighted.

$$\textbf{Aggregate Crushing Test} = \left(\frac{W2}{W1}\right) \times 100$$

Aggregate Crushing Value<10% = Strong.

Aggregate Crushing Value > 35% = Weak.

Figure 4.3 Crushing Test

4.2.3 AGGREGATE ABRASION VALUE TEST:

Abrasion test is to carry out testing the properties of aggregates instead of wheel load. When the vehicles are moving on the surface of the pavement, it prevents the abrasion effect between road surface and the tyres of vehicles. Confrontation towards abrasion is firm in workroom by Loss-Angeles Abrasion Examination. Percentage of wear of rubbing due to steel balls is determined in abrasion test.

Procedure:

- The sample is perfectly cleaned and completely oven dried at the rate of 110°C.
- Select the grading of the sample as per code and prepare the mix.
- Take a 5kg of example to classifying x, y, z, d and 10kg aimed at classifying p, q& r.
- Select the steel balls for each the type of aggregate and fix the mix in the drum.(48mm)
- Rotate the drum with a constant speed of 30-33 RPM with 500 rotations.
- Stop the drum after completion of rotations and remove the sample from the tray.
- Material coarser than 1.70mm is to be weighted. (Accurate weight should be done @1gram).
- Observations:

Weight of Agg. Sample = W_1 g.

Weight of sample retained = W_2 g.

Abrasion Value = $\left[\frac{W1-W2}{W1}\right] \times 100$

Figure 4.4 Abrasion Test

Table 4.3 Aggregate Abrasion Value

S.NO	Kind of Pavement	Maximum Abrasion value
1	WBM S-B course	60 percent
3	B.B.M	50 percent
4	WBM OVERLAY	40 percent
5	B.P.M	40 percent
6	C.C surfacing	35 percent
7	Bituminous concrete surfacing course	30 percent

4.2.4 WATER ABSORPTION AND SPECIFIC GRAVITY TEST:

Specific gravity and water absorption test is carried out to note the strength, quality and water absorption of the aggregates. Aggregates are less water absorption are weaker compared to high water absorption aggregates. It is recommended that water absorption should not be more than 0.6% by its weight of aggregate.

Procedure:

- Take a sample of 2kg of aggregates. Washed the aggregates and remove the fine particles from the surface of coarse aggregate.
- Soak the aggregates in the water beaker, minimum depth of aggregate should be 5cm. at the temperature of 22-32°C for 24hours.
- Take weight of water + vessel + sample and note down the total weight = W_1 g.
- Now remove the aggregate sample from the beaker and weight the vessel + fully filled water in beaker = W_2 g.
- Weight the saturated surface dry aggregates = W_3 g.
- Now put the aggregates in oven dried for 24hours @ 110°C.
- Weight the oven dry sample = W_4 g.

Figure 4.5 Water absorption test

Observations:

- Weight of sample
- Wt. of basin + water + sample (x) = W_1 gm.
- Wt. of basin + water (y) = W_2 gram.
- Wt. of inundated and dry sample(z) = W_3 gm.
- Wt. of kiln dry example (d) = W_4 gm.

Sp.gravity value = $\left[\frac{W4}{W3} - [W1 - W2]\right] \times 100$

Apparent Sp.gravity value = $\left[\frac{W4}{W4} - [W1 - W2]\right] \times 100$

Water absorption value = $\left[\frac{W3-W4}{W4}\right] \times 100$

- **The Specific Gravity should be 2.68.**

4.3 MARSHAL STABILITY VALUE TEST:

Marshall Stability value test, the conflict to the flexible bend of a cylindrical sample of asphalt blend is measured while the same is laden at an amount of 5 cm/min.

There are two fundamental things of the Marshall Stability technique for blend outline
(1) Density voids analysis and (2) Stability flow tests.

- The Marshall dependability of the mix is characterized as the most extreme load is conveyed by the specimen a standard temperature of 60°C.
- The stream esteem is the twisting of the test is attempts all through the stacking up to max. Load.
- Flow is stately in 0.25 mm units. An endeavour has made to get the level of ideal fastener content for the sort of total blend.

Apparatus:

1. Mould Gathering, cylinder-shaped moulds of 10cm (dia) & 7.5cm (height) containing of a base bowl and neckline delay lead.
2. Model Extractor: for expelling the compacted example from the form.
3. Compact podium and mallet. (20*20*45)
4. Defiance crown.
5. Filling device.
6. Movement measure, liquid soak, thermometers

Figure 4.6 Marshall Test

Properties of the Mix:

The properties of mix are the important elements in specimen those are Hypothetical sp gravity (G_t), the bulk sp gravity of the mixture (G_m), % mid-air cavities (V_v), % capacity of bituminous (V_b), % void in varied collection and % voids complete with tar. The calculations which we want are to be bearing in mind for the design of mix.

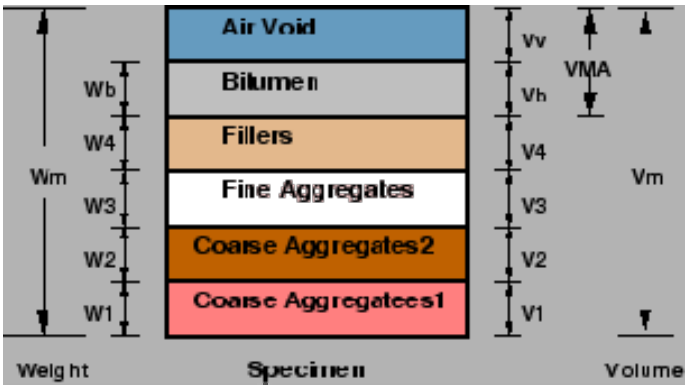


Fig 4.7 Marshall phase diagram

Procedure:

- Firstly, Taking aggregates in a different sizes (Fig) with different quantity of total 1200 grams for specimen.
- Pre heat the aggregates and heat the binder as well at a temperature of 140℃ to 150℃.
- The heaten aggregate and bituminous material are comprehensively blended at a high temperature of 150-165℃
- The mixture is placed in preheat mould after fix the mould tightly and compacted by a rammer with 76 blows on each sideways and compact it properly.
- Keep the specimen for 24 hours at a room temperature.
- Next day, demould the sample carefully with the help of rammer.
- Take the weight of sample in air (W_a).
- Submerge the sample in water and weigh the specimen (W_w).
- Keep the sample in hot water for 30 min at temperature of 60℃.
- After that specimen is keep in the Marshall apparatus.
- As the Marshall Stability of an experiment sample is the determined load essential to yield the catastrophe of sample while value of the specimen.
- However the solidity testings are in evolvement dial gauges are used to measuring the upright distortion of the sample.
- There will be two dial gauges upper is for Marshall Value and down dial gauge is to shows the flow value.
- The distortion at the miscarriage specified point stated as units of 0.25mm is named as Marshall Flow Value of the prepared sample.
- As the same procedure will be followed for various bitumen proportions for effective binder content for the mix. (Ex: 4, 4.5,5 etc.)

Table 4.4 Aggregate Arrangement for Base Coarse	
Sieve Size (mm)	Weight of Aggregate (Grams)
12.5	72g
10	312g
4.75	84g
2.36	204g
Filler(75 μ)	480g

- The arrangement of the aggregates are to be shown in table, it will be exceed for the mix of base course for Marshall Specimen as per IRC.
- The above table will shows the recommended values of Marshal value And Flow value As per IRC.

❖ Table 4.5 Recommended of Marshal value And Flow value As per IRC		
S.NO.	Description of specimen	Requirement
1.	Marshal Stability (ASTM D-1559) Determined on Marshall specimen compact. (Minimum 75 blows)	340kg(1800Lb) Min.
2.	Marshall flow in mm	2-4 mm
3.	% of Voids in mix.	3-5%
4.	% of Voids in Mineral Aggregate(VMA)	Minimum 11-13%
5.	% Voids in Mineral Aggregate filled.	65-75%
6.	Bitumen content, % by Wt. of Total mix.	Min 4.5 %

- The Above table shows the values considered with the different proportions of Bitumen percentages which gives the effective binder content of Marshall Test.
- Regarding this test which percentage of binder will be the optimum from the several blends. (Ex.5, 5.5, 6% of Bitumen etc.)
- The phase diagram will be using for the calculations.

Table-4. 6 The Results of Marshall Stability test (Marshal Value and Flow value)

S.NO	% Bitumen	Marshall Stability Value	Flow value	Bulk Density(G_m)	Air void %(V_v)	% of Bitumen(V_b)	VMA	VFB
1	4							
2	4.5							
3	5							
4	5.5							
5	6							

Calculations:

- sample weight in air (W_a) =
- sample weight in water (W_w) =
- Coarse aggregate weight (W_1) =
- Fine aggregate weight (W_2) =
- Filler weight (W_3) =
- Bitumen weight (W_b) =
- Sp.gravity of Coarse aggregate (G_1) =
- Sp.gravity of F.A (G_2)
- Sp.gravity of Filler (G_3) =
- Sp.gravity of Bituminous material(G_b) =

❖ The Sp. gravity of specimen / bulk density (G_m)

The bulk density of the sample is regularly determined by weighing the sample in air & water. It might be necessary to coat trials with paraffin before formative density. The sp.gravity ($G_{m)}$ of the sample is given by

$$\mathbf{G_m = \left[\frac{Wa}{Wa - Ww}\right]}$$

❖ Theoretical Specific gravity without considering the air void :(G_t)

The Theoretical Sp. gravity considering devoid of the air voids (G_t), and it given by:

$$\mathbf{G_t = \left[\frac{W1+W2+W3+Wb}{\frac{W1}{G1}+\frac{W2}{G2}+\frac{W3}{G3}+\frac{Wb}{Gb}}\right]}$$

❖ The Air voids percent (V_v):

The Mid-air voids (V_v) is the ratio of air cavities by capacity in the sample and it is identified as:

$$\mathbf{V_v = \left[\frac{Gt - Gm}{Gt}\right]}$$

❖ The percentage Volume of Bitumen(V_b):

The capacity of bitumen (V_b) is the % of bitumen to the total size and it specified by:

$$\mathbf{V_b} = \left[\frac{\mathbf{Wb}}{\frac{\mathbf{W1+W2+W3}}{\mathbf{Gm}}}\right]$$

❖ The Cavities in inorganic minerals aggregate (V.M.A):

The Voids in inorganic aggregate constitutes (V.M.A) is the capacity of spaces in aggregate and is amount of capacity of bituminous and air voids, and it is considered from

$$\mathbf{V.M.A} = [\mathbf{Vv} + \mathbf{Vb}]$$

❖ Voids filled with bitumen (VFB):

The Cavities are occupied by bitumen in mineral aggregate frame effort filled with the bitumen, and it is designed as

$$\mathbf{V.F.B} = \left[\frac{\mathbf{Vb \times 100}}{\mathbf{VFB}}\right]$$

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