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Reclaimed Asphalt Pavement

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***Abstract*—Use of reclaimed asphalt pavements in hot mix asphalt combinations has developed right into a everyday practice in many countries round the world. Use of those substances in the past has proved to be inexpensive and environmentally sound. Mixing rap in virgin substances has been substantially preferred over virgin materials due to the growing price of asphalt, scarcity of right nice combination, shortage of asphalt and the ever growing need to preserve the surroundings. The literature survey contexts that use of reclaimed asphalt pavement is powerful in enhancing the performance that's identical to or better than the virgin combos. Regrettably, asphalt pavement recycling is yet to take off in India notwithstanding the modern ambitious street constructing program underway. This has created a want to use rap.**

***Index Terms*—Low cost, Alternate Road materials, recycled aggregate.**

I. INTRODUCTION

It also helps in economic development for a sturdy and strong economy true roadway infrastructure is necessary collectively with the opposite development sports activities avenue infrastructure is growing at a completely rapid price in india. In this contemporary generation dual carriageway transportation has high pace, excessive load, high traffic density and channelized visitors, so as a result pavements are subjected to specific kinds of distress collectively with fatigue, cracking and so forth and also the lifestyles span of roads laid with conventional bituminous mixes has decreased due to the growth inside the website site visitor's growth and overloading of automobiles

. The problem specifically arises due to numerous weathers, terrain condition, rainfall intensities and soil developments.

Significance and objectives of on-going research

- To determine the basic engineering properties of the Virgin bitumen and binder after extraction and Recovery.
- To work out the economics of recycling of bituminous pavement materials.
- To perform the mixture layout for 10%, 30%, 50% reclaimed mixes with virgin mixes

II. THEORY AND CONCEPTS

This chapter describes the principle and ideas in the back of the prevailing look at which incorporates the ideas of recycled asphalt pavements technology, laboratory concepts.

1.1 Methods of Recycling Pavements:

Generally, there are three types of method

1.1.1 Hot in place recycling (HIR)

1.1.2 Cold in place recycling (CIR)

1.1.3 Full depth reclamation (FDR)

2.1.1 Hot in place recycling (HIR):

Hot in place recycling has been defined as an insitu

technique that rehabilitates deteriorated asphalt pavements and thereby minimizes the use of recent materials. Essentially this process includes 4 steps:

(1) softening of the asphalt pavement surface with warmth
(2) scarification and/or mechanical removal of the surface fabric
(3) mixing of the material with recycling agent, asphalt binder, or new mix

lay down and paving of the Reclaimed mix at the pavement

2.1.2 : Cold recycling:

This process consists 2 parts cold milling and cold in place recycling (CIR)

i) Cold in place recycling (CIR): it is defined as a rehabilitation approach in which the present pavement materials are reused insitu. The substances are blended collectively without the application of heat. The reclaimed asphalt pavement material is acquired through milling or crushing the existing pavement. Sparkling combination or recycling agent or each are introduced to the rap fabric, that is sooner or later laid and compacted. Bloodless in region recycling can restore the original profile of antique pavements, put off existing wheel ruts, restore the crown and pass slopes and put off pot-holes and hard areas.

ii) cold milling: it is a method of routinely controlling the removal of pavement to a favored depth the use of specially designed equipment and restoration of the floor to a unique grade and slope, without bumps, ruts and/or other imperfection. The present-day bloodless milling gadget has tungsten carbide enamel constant on drums, with adjustable reducing width for a selection of pavements and remarkable maneuverability for one-of-a-kind milling situations.

2.1.3 Full Depth Reclamation (FDR):

It's been described as a recycling approach where all the asphalt pavement phase and the pre-decided number of underlying materials are treated to supply a stabilized base route.his method is normally executed to a intensity of one hundred to 300 mm. The main blessings and benefits of complete depth reclamation are as follows:

1. The shape of the pavement can be advanced drastically without converting the geometry of the pavement and shoulder reconstruction.
2. It is able to repair vintage pavement to the preferred profile, do away with wheel ruts, restore crown and slope, and eliminate pot holes, irregularities and tough regions.

III. METHODOLOGY

3.1. Materials selection
3.2. Laboratory tests
3.3. Lab test result
3.4. Comprasion

3.1 Material selection: The reclaimed bitumen was obtained from the broken pavement near the IIM kashipur.

3.2. These are the lab tests which are performed

3.2.1. Penetration test (IS : 1203-1978)

3.2.2. Ductility test (IS : 1208-1978)

3.2.3. Viscosity test (IS : 1206-1978)

3.2.4. Softening point test(IS : 1205- 1978)

3.2.5. Flash and fire point test (IS : 1209-1978)

3.2.6. Specific gravity test (IS : 1202-1978)

3.2.7. Dynamic Shear Rheometer

3.1.1 Penetration test: Maximum generally use approach for comparing the consistency of bitumen in a specific temperature.

In place of a measure of excellent it's miles a median of classification. We check the consistency of sample of bitumen by using way of identifying the space in 10th of mm that a popular needle perpendicularly penetrates the bitumen sample under genuine situations of time, temperature and load.

3.1.2. Ductility test: This test measures the adhesive properly of bitumen and it’s ability to stretch. The test is conducted at 27degree c and at a rate of pull of 50mm per minute.

3.1.2 Visocity test: Viscosity is the assets of bitumen which impacts the potential of bitumen to unfold, penetrate into the voids and also coat the aggregates. This is it affects the fluid property of bitumen. If viscosity of bitumen is better, compactive attempt of bitumen reduces and heterogeneous aggregate arises. If viscosity is lower, then it'll lubricate the aggregate debris. Viscosity is determined through using tar viscometer. The viscosity of bitumen is expressed in seconds is the time required for the 50 ml bitumen sample to bypass via the orifice of a cup, under general situations of check and at unique temperature.

3.1.3 Softening point test: Softening factor of bitumen suggests the point at which bitumen attains a specific diploma of softening underneath specified conditions of the take a look at. Take small amount of bitumen pattern and warmth it as much as 75–100-degree C. Ring and ball apparatus is used to conduct this test. Warmth the rings and observe glycerin to prevent from sticking. Fill this earring with bitumen and get rid of the extra material with warm sharp knife.

3.1.4 Flash and fire point test: Flash point of bitumen is described because the point of lowest temperature at which bitumen catches vapors of test flame and fires inside the form of flash. Fire factor of bitumen is described as the point of lowest temperature at which the bitumen ignites and burns as a minimum for five 2nd underneath unique conditions of take a look

Flash and fire factor check allows to control fireplace accidents in bitumen coated regions. Via this test we can determine the bitumen grade with respect to temperature for specific regions of high temperatures.

3.1.5 Specific gravity test: To determine the specific gravity of semi-solid bitumen avenue tars, creosote and anthracene oil as according to is: 1202 – 1978. The principle is that it's miles the ratio of mass of a given volume of bitumen to the mass of an equal volume of water, each taken at a recorded/particular temperature.

3.1.6 Dynamic Shear Rheometer: Dynamic shear rheometer (Dsr) is used to characterize the viscous and elastic conduct of asphalt binders at medium to excessive temperatures. This characterization is used within the super pave pg asphalt binder specification. As with other super pave binder tests, the real temperatures anticipated within the vicinity where the asphalt binder will be positioned decide the take a look at temperatures used.

IV. RESULTS AND DISCUSSIONS

4.1. Penetration Test

ACTUAL TEST TEMPERATURE = 25 ° C

		TEST 1	TEST 2	TEST3
PENETROMETER READING				
INTIAL		210	264	308
FINAL		264	308	355
PENETRATION VALUE		54	44	47

MEAN PENETRATION VALUE= 48.33

4.2. SOFTENING POINT

	1	2
TEMPERATURE WHEN THE TAIL TOUCHES BOTTOM	46	47

AVERAGE =46.5

SOFTENING POINT OF BITUMEN = 46.5°C

4.3 DUCTILITY TEST

TEST OF OBSERVATION BITUMEN GRADE =*VG30*

. *TEST TEMPERATURE °C=27*

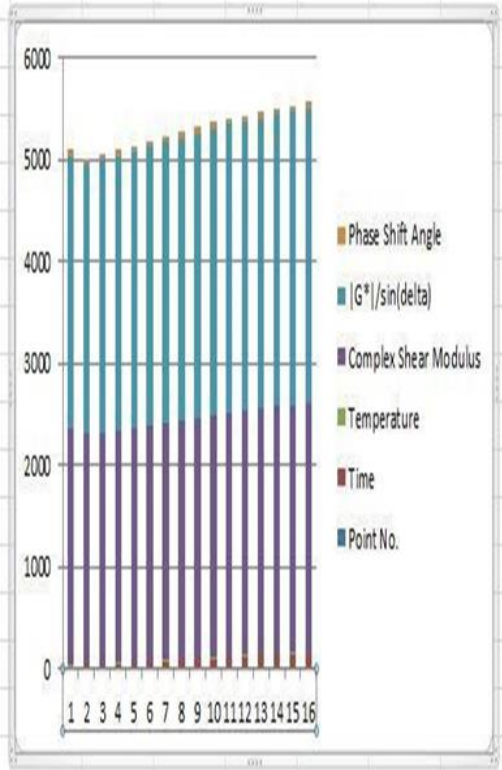
	BRIQUETTE NO 1	2	3
INTIAL READING	0	0	0
FINAL READING	76.8	75.8	76
DUCTILITY (F-I)	76.8	75.8	76

DUCTILITY VALUE = 76.2

4.4 DIRECT SHEAR RHEOMETER

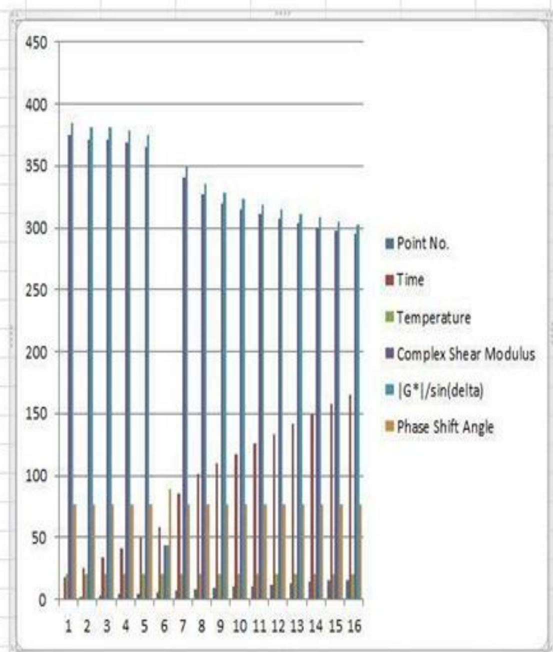
DSR TEST @ 10° C

Point No.	Time	Temperature	Complex Shear Mo	|G*|/sin(delta)	Phase Shift Angle
	[s]	[°C]	[kPa]	[kPa]	[°]
1	17.5	10	2326.4	2685.5	60.03
2	25.5	10	2263.4	2652.8	58.56
3	33.5	10	2276.2	2673.6	58.36
4	41.5	10	2291	2693	58.29
5	49.5	10	2306.3	2712.7	58.23
6	57.5	10	2322.4	2733.3	58.18
7	65.5	10	2337.7	2752.8	58.12
8	73.5	10	2351.7	2770.8	58.07
9	81.5	10	2368.7	2793	58
10	89.5	10	2386.1	2815.8	57.93
11	97.5	10	2398.3	2831.6	57.89
12	105.5	10	2406	2841	57.87
13	113.5	10	2416.7	2854.4	57.85
14	121.4	10	2428.2	2869.1	57.81
15	129.4	10	2439.9	2883.9	57.78
16	137.4	10	2449.7	2896.3	57.76



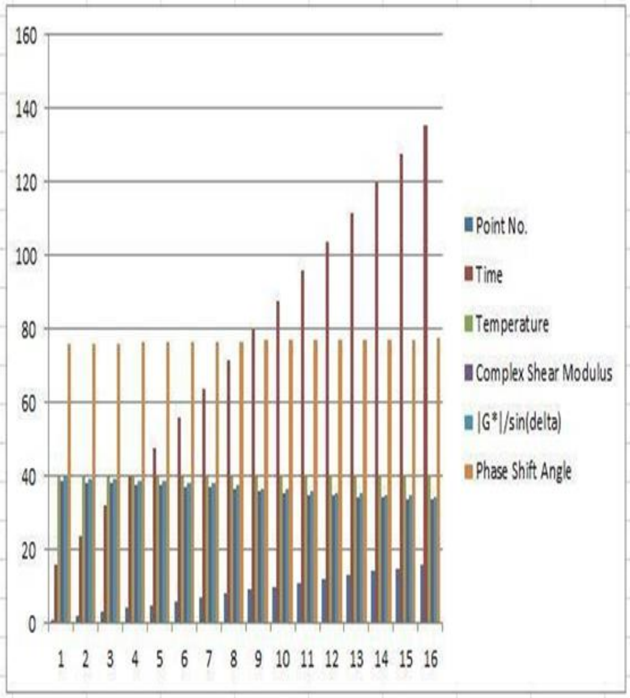
At_DSR TEST @20°C

Point No.	Time	Temperature	Complex Sh(	|G*|/sin(delta	Phase Shift Angle
	[s]	[°C]	[kPa]	[kPa]	[°]
1	17.8	20	375.2	385.2	76.91
2	25.8	20	371.2	381.1	76.92
3	33.8	20	370.8	380.6	76.98
4	41.8	20	368.5	378.1	77.03
5	49.8	20	365	374.5	77.02
6	57.8	20	43.6	43.6	89.55
7	85.7	20	340.3	349.5	76.84
8	101.7	20	326.5	335.3	76.85
9	109.7	20	320.3	328.8	76.94
10	117.7	20	315	323.3	76.99
11	125.7	20	310.7	318.8	77.02
12	133.7	20	306.9	315	77.04
13	141.7	20	303.4	311.3	77.06
14	149.7	20	300.6	308.4	77.08
15	157.7	20	297.6	305.4	77.09
16	165.7	20	295.3	302.9	77.11



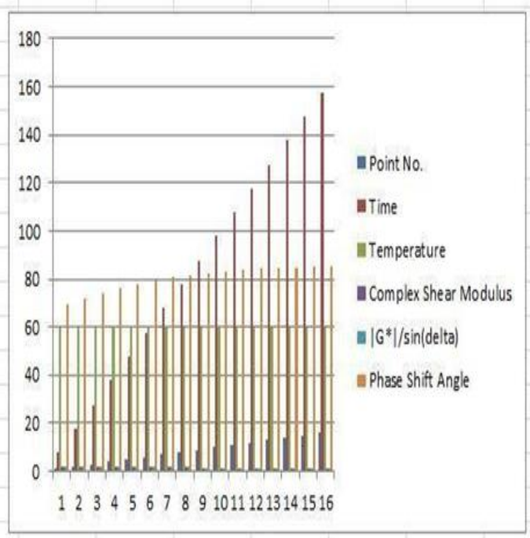
At 40º C

Point No.	Time	Temperature	Complex Sh	|G*|/sin(delta	Phase Shift Angle
	[s]	[°C]	[kPa]	[kPa]	[°]
1	15.8	40	38.6	39.9	75.67
2	23.8	40	38.2	39.4	75.91
3	31.8	40	38	39.1	76.09
4	39.8	40	37.6	38.7	76.24
5	47.8	40	37.4	38.5	76.37
6	55.8	40	37	38.1	76.48
7	63.7	40	36.8	37.9	76.58
8	71.7	40	36.5	37.5	76.68
9	79.7	40	35.7	36.7	76.88
10	87.7	40	35.4	36.3	76.93
11	95.7	40	35	35.9	77.04
12	103.7	40	34.7	35.6	77.13
13	111.7	40	34.4	35.3	77.18
14	119.7	40	34.1	35	77.22
15	127.7	40	33.8	34.7	77.27
16	135.7	40	33.5	34.4	77.39



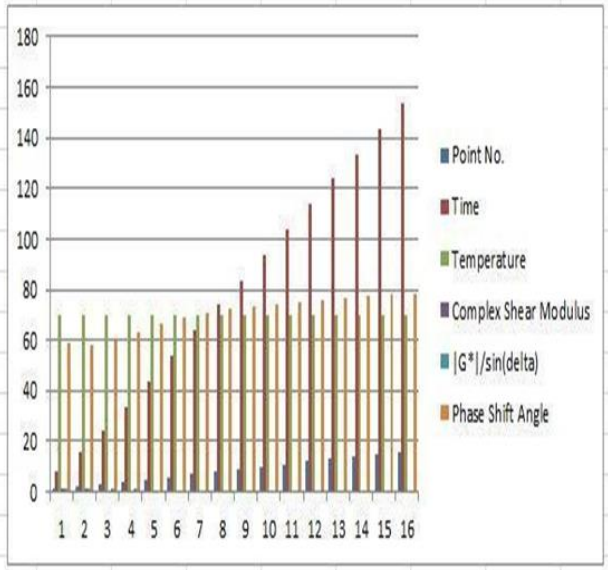
At 60º C

Point No.	Time	Temperature	Complex Shear	|G*|/sin(delta	Phase Shift Angle
	[s]	[°C]	[kPa]	[kPa]	[°]
1	7.8	60	2.1	2.2	69.53
2	17.8	60	1.9	2	71.81
3	27.8	60	1.8	1.8	74.19
4	37.8	60	1.7	1.8	76.21
5	47.7	60	1.7	1.7	77.91
6	57.7	60	1.6	1.7	79.43
7	67.7	60	1.6	1.6	80.59
8	77.7	60	1.6	1.6	81.51
9	87.7	60	1.5	1.5	82.32
10	97.7	60	1.5	1.5	83.07
11	107.6	60	1.5	1.5	83.7
12	117.6	60	1.5	1.5	84.19
13	127.6	60	1.4	1.5	84.56
14	137.6	60	1.4	1.4	84.86
15	147.6	60	1.4	1.4	85.13
16	157.6	60	1.4	1.4	85.43



At 70º C

Point No.	Time	Temperature	Complex Shear	|G*|/sin(delta)	Phase Shift Angle
	[s]	[°C]	[kPa]	[kPa]	[°]
1	7.8	70	1	1.1	58.71
2	15.8	70	1	1.1	57.79
3	23.8	70	0.9	1.1	59.62
4	33.8	70	0.9	1	63.07
5	43.7	70	0.8	0.9	66.31
6	53.7	70	0.8	0.9	68.62
7	63.7	70	0.8	0.8	70.71
8	73.7	70	0.7	0.8	72.03
9	83.6	70	0.7	0.8	73.06
10	93.6	70	0.7	0.7	73.96
11	103.6	70	0.7	0.7	74.71
12	113.6	70	0.7	0.7	75.57
13	123.6	70	0.7	0.7	76.3
14	133.5	70	0.7	0.7	77.14
15	143.5	70	0.6	0.7	77.94
16	153.5	70	0.6	0.6	78.7



V. RESULT AND DISCUSSIONS

5.1 General

RAP modified asphalt binder sample were tested for physical properties according to the method describes in chapter 4. The observation made on the results are presented and discussed in the following paragraphs.

5.2 Extraction And Evaluation of Bitumen from the RAP

After extracting the binder from rap with the aid of centrifuge extractor, the extracted answer turned into subjected to outside for the healing of binder. The diluted pattern (bitumen + benzene) to be processed became fed directly into the deep tray. The sample is saved for the exposure to ecosystem, in certain time the benzene gets evaporated and bitumen is left over.

5.3 Evaluation Of Binder Mixed With Different Percentages Of RAP

The virgin bitumen became heated to around 900c and become blended with unique possibilities of recovered binder which have been also preheated to round 900c varying from 10 to 50%. The fundamental

checks had been performed for assessment of binders for diverse primary houses.

Materials	Proportion of mixing						
RAP bitumen	10%	20%	30%	40%	50%	100%	---
Virgin Bitumen	90%	80%	70%	60%	50%	---	100%

Schedule Of Different Proportions of Mixing

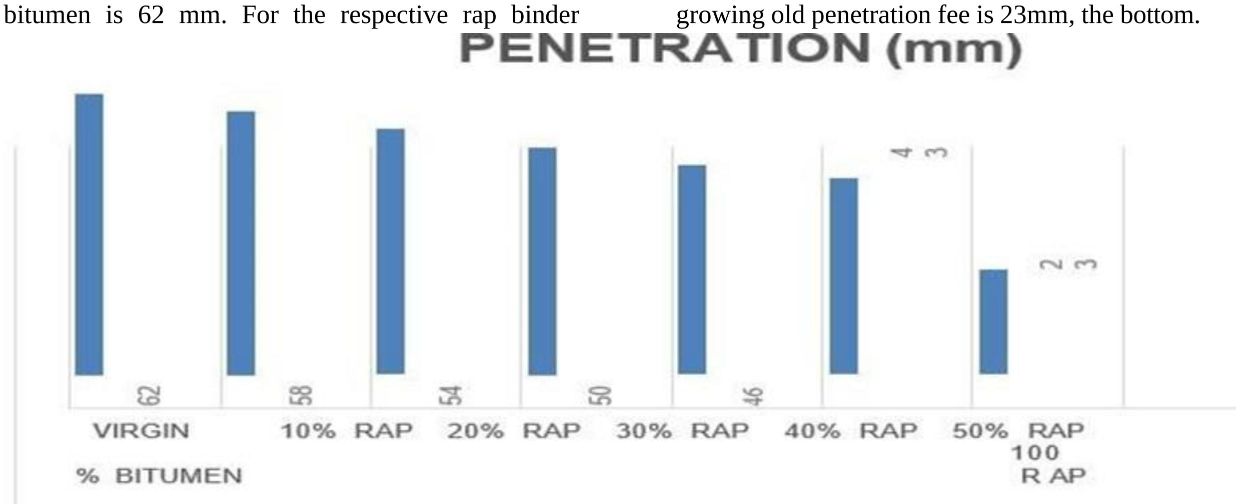
Tests on bitumen	Virgin bitumen	10% RAP	20% RAP	30% RAP	40% RAP	50% RAP	RAP bitumen	IS limits (min)
Penetration test (mm)	62mm	58mm	54mm	50mm	46mm	43mm	23mm	60/70
Softening point test (^{0}C)	46 °C	48°C	50°C	53°C	58°C	61°C	64°C	45-55°C
Ductility test (cm)	>75cm	62cm	58cm	54cm	45cm	33cm	16cm	75cm

Comparison Between Reclaimed Asphalt Pavement (RAP) And Virgin Bitumen Properties

Penetration

The penetration decreases as the share of rap binder increases because of the loss of volatiles within the elderly rap binder. The penetration cost of virgin bitumen is 62 mm. For the respective rap binder proportions, with the boom of rap % penetration decreases and for 100% rap bitumen after the long term

growing old penetration fee is 23mm, the bottom.

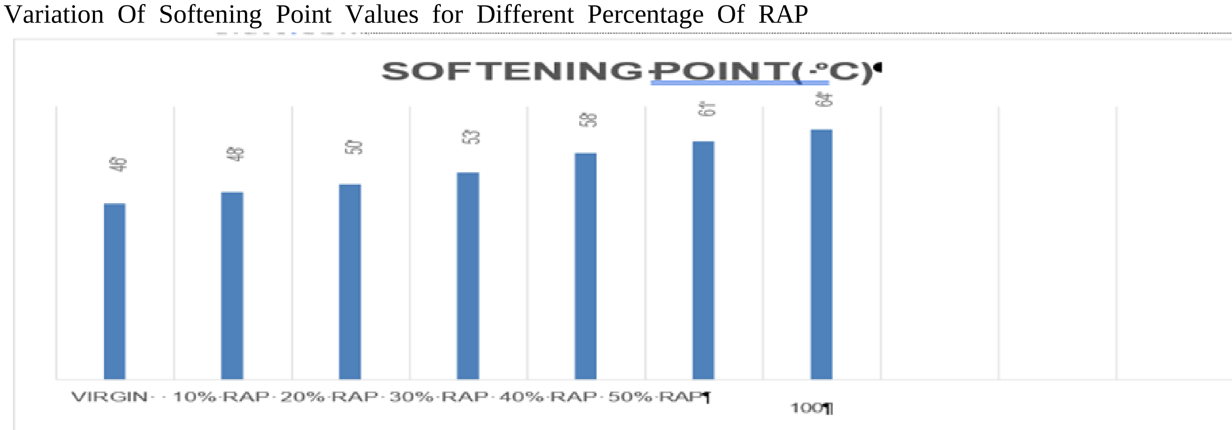


Variation Of Penetration Values For Different Percentage Of RAP

Softening Point

The softening factor of all rap binder proportions increases as they undergo getting older because of hardening. A 100% rap bitumen famous the best softening factor at 64°c after being subjected to long time aging, whereas virgin bitumen has a softening point of 45°c. Discern increase of softening point values, respectively of rap changed binders.

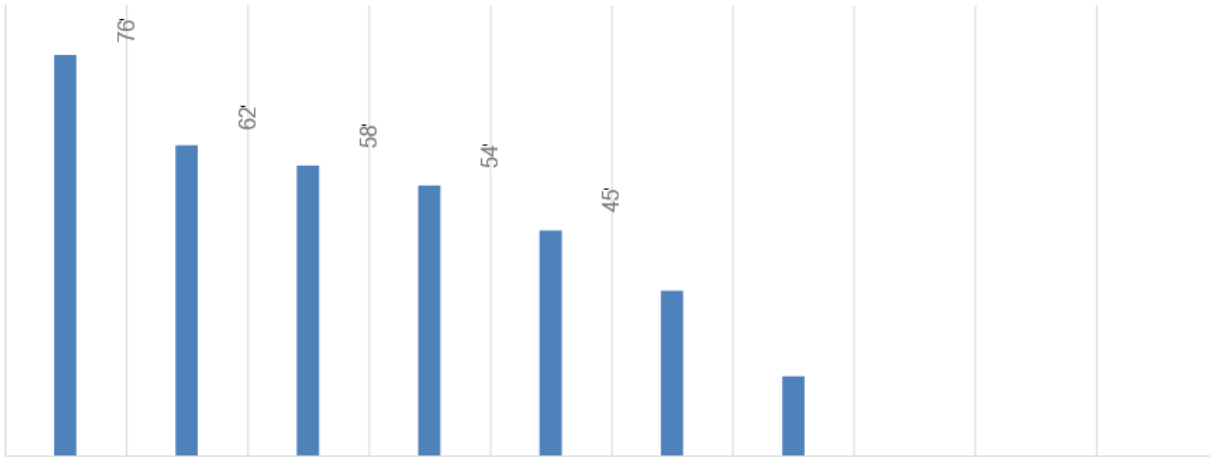
Variation Of Softening Point Values for Different Percentage Of RAP



Ductility:

The ductility decreases as the share of rap binder will increase due to the loss of volatiles within the elderly rap binder. The ductility price of virgin bitumen is 80 cm. For the respective rap binder proportions, with the growth of rap % ductility decreases and for 100% rap bitumen after the long time getting older ductility value is 16 cm, the bottom.

Variation Of Ductility Values For Different Percentage Of RAP



VI. CONCLUSION

The following conclusions are derived on the use of recycle RAP

- Asphalt recycling will be environmentally friendly, cost-effective, and work on asphalt recycling will begin.
- RAP is a revolutionary technology that allows for the construction of bituminous pavement at a lower cost by repurposing outdated pavement components.
- RAP technology ensures resource optimization and promotes long-term development.

REFERENCES

[1] A Study on Use of Reclaimed Asphalt Pavement (RAP) Materials in Flexible Pavements (International Journal of Innovative Research in Science, Vol. 4, Issue 12, December 2015

[2] Study on Reclaimed Asphalt Pavements (© March 2018 | IJIRT | Volume 4 Issue 10 | ISSN: 2349-6002)

[3] Luis Guilherme de Picado Santos, et al, "Assessment of the Use of Hot-Mix Recycled Asphalt Concrete in Plant", Journal of Transportation Engineering, Vol. 136, ASCE, No. 12, December 2010

[4] Characterization of Indian reclaimed asphalt pavement (rap) on the basis of sources of rap and gradation characteristics of rap aggregates. (International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-7, May, 2019

[5] Study on Reclaimed Asphalt Pavements (March 2018 | IJIRT | Volume 4 Issue 10 | ISSN: 2349-6002) Krupa S. Sharma, Ashok Patel)