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Performance Evaluation of Recycled Asphalt Aggregate with Styrene Butadiene Rubber (SBR) Latex

Faraz Ali Channa[1*], Muhammad Abbas Khan[2], Muhammad Qamer[3], Saad Zaheer[4], Sameer Ahmed Mufti[5], Shaista Amina[6]

[1] *School of Civil Engineering, Tianjin University, Tianjin, China.* E-mail: Farazaleechanna@gmail.com

[2] Technical Education and Vocational Training Authority (TEVTA), Khyber Pakhtunkhwa, Pakistan. E-mail: abbass_khan_15@hotmail.com

[3] State Key Laboratory of Hydraulic Engineering, Simulation, and Safety, Tianjin University, Tianjin, China. E-mail: chqamer306@tju.edu.cn

[4] Centre of Excellence in Water Resources Engineering, University of Engineering and Technology (UET), Lahore, Pakistan, Civil Engineering Department, Bahauddin Zakariya University, Multan, Pakistan. E-mail: saad.ahmad4456@gmail.com

[5] High Design Engineering, Creative Engineering Consultant, Peshawar, Pakistan, E-mail: sam.mufti@gmail.com

[6] University of Sindh, Jamshoro, Pakistan, E-mail: Shaistawahab1011@gmail.com

Abstracts: When it comes to highways and the building sector, aggregate is essential. In this study, recycled asphalt aggregate from wearing coarse asphalt pavement were used and designed it for binder coarse to boost the aggregate's strength. Bitumen, SBR latex, and asphalt mix aggregate are the primary components used in the study. Bitumen contents of 0%, 5%, 10%, and 15% of SBR latex were used. The Los Angles abrasion test, sieve analysis, absorption, vacuum-powered desiccator, centrifuge extract, and marshal stability test were the principal experiments conducted in this investigation. It has been determined through experimentation that Gmb begins to increase at 0 to 10% SBR before starting to decrease. Additionally, stability begins to increase between 0 and 10% SBR before declining between 10 and 15%. As the SBR % increases, the void ratio decreases. While normal aggregate flow value is less than recycled asphalt aggregate with SBR, flow value increases as SBR percentage increases. It was discovered that the optimum SBR is 10%, offering the highest level of flow and stability.

Keywords: Recycled Asphalt Aggregate, Styrene Butadiene Rubber (SBR) Latex, Bitumen, Marshal Stability, Flow, Centrifuge

1. INTRODUCTION

Aggregates are an excellent example of a building material that is in high demand due to more sustainable sources and environmental concerns shared by both businesses and individuals. This year, 200 million tons of aggregate will be consumed in the UK, of which 57 million tons will come from recycled resources. According to Khodair and Luqman (2017), recycled aggregates are growing more and more in demand than virgin aggregates. Depending on what you want, they can be made from recycled or new materials. Recycling from construction and demolition waste was developed much later than other material recycling techniques, such as recycling metals, which were discovered far earlier. Natural resource availability in Spain and the nation's general economic condition were significant factors. Aggregates were produced after World War II. A drastic substitute would be soft crushers that can separate a significant amount of the attached mortar. The fines from this procedure could be used to manufacture special cement, which is a reasonable alternative under the conditions. Certain scholars are in favor of using more cement than is usually used in standard gravel and cement pavement. More glue is applied to limit the permeability of the paste and make up for the loss in compressive strength. To determine whether the CO2 emissions from the production of cement are acceptable in each situation, a life cycle assessment (LCA) can be used (Barbudo et al., 2018).

The results suggest that incorporating SBR latex into the current pavement mayresult in the creation of a new type of pavement. The construction and design of pavements are always evolving. Pavement performance improves when low-cost substitutes for conventional, expensive pavement components are introduced. After being used on a high-performance pavement, latex-manufactured SBR rubber was assessed (Y. Yang et al., 2019). Pavement samples are subjected to compressive, tensile, and flexural tests. The purpose of the study was to determine how adding polymers to pavement could increase its reliability and durability. It has been determined how much SBR latex is suitable for pavement. The pavement samples treated with SBR were assessed for both compressive and flexural strength.

It was decided to use SBR latex in the reinforced pavement following a thoroughanalysis of the effects of the new pavement design. Furthermore, a standard addressedhigh-cement pavements. To carry on working in this scenario, SBR latex needs to be changed. Examine the differences between recycled and natural aggregate in terms of specific gravity and absorption capacity. According to Chan et al. (2019), recycled aggregates have lower crushing strength and impact value than fresh aggregates. For the same combination, PMRAC sags more. The polymer's use improves recycled aggregate pavement. A pavement's water consumption can be decreased by adding polymer. When employing lower-quality water, the ratios of water to cement are smaller. 10% more compressive strength is achieved with recycled aggregate that contains polymers. After a careful evaluation of the implications of the new pavement design, it was determined to utilize SBR latex in the reinforced pavement. Moreover, a standard addressed pavements with a lot of cement. SBR latex needs to be updated to continue working in this environment. Compare the specific gravity and absorption capacity of natural and recycled aggregate. Recycled aggregates have a lower impact value and crushing strength than fresh aggregates, according to Chan et al. (2019). PMRAC sags more for the same combination. The application of the polymer enhances pavement made of recycled aggregate. By adding polymer, a pavement's water use canbe reduced. The water-to-cement ratios are smaller when using poorer-quality water. A recycled aggregate containing polymer achieves a 10% increase in compressive strength. Styrene-butadiene rubber, styrene-butadiene crumb rubber, and ethylene-vinyl acetate are the three most widely used polymers for asphalt. The main issues with asphalt binder are permanent deformation at high temperatures and cracking at low temperatures. High-stress areas including interstates, crossroads, and airports have successfully used these polymer combinations. Asphalt voids can be reduced bycombining pozzolanic and SBR. Adding steel fibers to pavement increases its compressive strength by 2%. The local production of SBR latex makes concrete more slowly. SBR-Latex helps prevent water from seeping through pavement surfaces. Because SBR latex tends to rubberize, the dosage needs to be changed to keep the pavement usable. The best results came from cement pavements that had at least 15%latex mixed in. When the useful life of an asphalt road is almost over, it's standard procedure togrind down the current surface and replace it with new hot mix asphalt. Reclaimed asphalt pavement is produced annually in considerable quantities by this procedure. Eight 0.3 million tons of this amount are made of recycled and repurposed materials. Reclaimed asphalt pavement (RAP) is a common use for most RAPs handled in the US.RAP as granular foundation material may be advantageous for shoulders, parking lots,bike lanes, asphalt and unpaved roads, and gravel road restoration (J. Li et al., 2014). Although CBR is a genuine mechanical property, pavement specialists have recently discovered that CBR is not useful for pavement design calculations. Because of this, CBR is being used less frequently in pavement design. When the concentrationof RAP was raised, the longer-term there was also an increase in deformation (Fang etal., 2016). Because of the higher stabilizing agent content, RAP deformation was reduced. Recycling techniques for garbage from construction and demolition projects came after those for metals. An extensive crushing and screening process is used to produce well-graded, premium aggregates for RAP, which are then covered in an asphalt cement layer. Grinding down asphalt pavement to a depth of several feet is the most common methodof eliminating it. It is common for front-end loaders to pick up and move the broken debris to a processing facility (Zhou et al., 2016).

Self-propelled pulverizers can be used for on-site pulverization of old asphalt pavements, even though most old asphalt pavements are recycled by central processing facilities. In-place recycling methods, whether hot or cold, can benefit from this. Though not always in the year of manufacture, the vast majority of RAP produced is recycled and put to good use. While recycled RAP can also be used as an aggregate inthe sub-base or foundation of a road, asphalt paving is the most common application forit. Phodair and Luqman (2017) observed comparable patterns in industrialized nations such as the US and Japan. What is the probability of reclaimed pavement? There may be considerable long-term shrinkage and creep in recycled pavement when 30 to 50% of the original gravel is replaced. The pavement's ability to withstand water and strong solutions will predict its chemical and freezing resistance. Requirements for disposal ofasphalt concrete are thought to be low, less than 20% of annual production. An emulsion polymer that finds extensive application in both industrial and commercial contexts is styrene-butylene latex or SB latex. Because it is made up of two different monomers styrene and butadiene, it is a copolymer. As a byproduct of the styrene-benzene process, butadiene is created by the synthesis of ethylene (J. Li et al., 2017). Researchers have been working to enhance the qualities of natural rubber for decades. In the early 1800s, Charles Goodyear invented vulcanization, which is the process of combining latex rubber with sulfur and lead oxide to produce a more resilient rubber. Styrene-butadiene latex is made from polymer emulsions. In addition to carboxylic acids and other specific monomers, surfactants, and initiators are also employed. After the new pavement design was studied, the use of SBR latex in the reinforced pavement was approved. SBR latex needs to be used in place of additional standards for high-cement pavements in this situation (Lv et al., 2018). The recycled aggregate's absorption and specific gravity, impact value, and crushing strength are lower than those of contemporary materials. To provide a high gloss, exceptional printability, and oil and water resistance in paper goods including catalogs, flyers, and magazines, SB latex formulae are frequently utilized. SB latex makes paper smoother, brighter, and more water-resistant. The additional advantage of SB latex over other coatings is its significantly lower cost. Because of its low coefficient of thermal expansion, SB latex is a recommended solution for adhesives in the flooring industry (Yang, Y., and others, 2019).

Hot-mix asphalt's significant carbon dioxide emissions are one of its main selling points. Recent attempts to reduce the temperature have been the result of this. In the ongoing effort to create low-carbon, environmentally friendly roadways, there isgrowing interest in recycled cold asphalt heated to room temperature. Research on warm asphalt pavements is still ongoing. Marshall's stability indicates that modified emulsified asphalt is more stable than regular asphalt, regardless of the quantity of emulsion mixing (Han et al., 2021). Recycled pavement aggregates have decreased building costs and promoted waste recycling. The mechanical properties of recycled pavement have been altered by the significant influence that occurred during the aggregates' lifespan and was present in the original pavement. Bonding issues may arisefrom the usage of smooth recycled pavement aggregates. Excellent mechanical qualities and long-term splitting tensile strength are determined by recycled pavementaggregates' water absorption and other crucial features. Because a polymer was used in place of the regular emulsified asphalt to increase the interfacial adhesion between particles, modified emulsified asphalt required less time to cure than hardened asphalt.As the emulsion mixing increased following the failure of the test specimen, the Marshall stability considerably improved, lowering binder delamination. This increases the binder's low-temperature endurance and decreases expansion-related cracking in addition to enhancing adhesion and tensile strength (Q. Li et al., 2021). Since recycled pavement aggregates are usually inspected after usage, their mechanical qualities serve as the primary performance criterion in this study. Because of this, the aggregate's mechanical qualities greatly enable it to satisfy the specifications from the beginning and guarantee that the recycled pavement can support the same weight as regular pavement. By dispersing uniformly throughout the mixture, it improves the flexibility of asphalt. Still, regardless of the type of asphalt, the flow value rose with increasing amounts of asphalt emulsion; yet, the total amount (Q. Li et al., 2021). Reduced flow rate under mixing conditions with improved Marshall Stability was a result of recycled asphalt andaggregate adhesion improving internal cohesion.

The strongest material's maximum strength under the best Marshall Stability scenario is 0.95 MPa. As a result, it enhanced the specimen's resistance to compressive force applied perpendicular to the specimen. Tests performed at the location revealed that the pervious concrete with recycled aggregate had a higher void ratio than that of pervious concrete with natural coarse aggregate (Abedalqader et al., 2021). Pervious concrete's permeability and void ratio were decreased by the use of Styrene Butadiene Rubber Latex. According to earlier research conducted in 2015 by Byung Jae Lee with non-cement binder and SBR percentages of 10 and 20, the stability is 39000N and 45000N. He employed cold, reclaimed asphalt.

The following are the objectives of the study.

- To determine the behavior of pavement modified with SBR latex.
- To evaluate the feasible percentage of SBR latex for pavement modified withrecycled pavement aggregates.

2. MATERIALS AND METHOD

The study's overall methodology must take into account the experimental data from the samples and ensure that the two materials for which the binder is being evaluated are properly replaced.

2.1. Recycled Asphalt Aggregate

Even though the majority of outdated asphalt pavements are recycled at central processing facilities, an on-site self-propelled asphalt pavement pulverizer may be employed. It covers both in-place recycling techniques that are heated and cooled. You can make them with new or repurposed materials. There is an immediate demand for environmentally friendly road construction methods. Recycled asphalt aggregate materials can be used in road construction to reduce its impact on the environment. Pavement debris made up a sizable portion of these aggregates. The reason for this is that clearing gravel and sand from the environment hurts the ecosystem. Sometimes, when asphalt roads are getting close to the end of their usable lives, the old asphalt is ground down and fresh hot mix asphalt is applied. An enormous volume of recovered asphalt pavement is produced annually using this technique. The recycled aggregate utilized in this study came from nearby recycling facilities, and the same quantity was used in each sample. In front of SCET, on the main Shahbazpur road(wearing surface), RYK, was where asphalt mix aggregate was obtained.

2.2. Bitumen

A complex mixture of heavy hydrocarbons makes up bitumen. It is necessary toremove bitumen found in an oil reservoir. To extract it into a high-quality product, a lotof labor and heat are required. Bitumen may be brought to the surface by oil leaks, evenif it is impossible to excavate. Instead of being buried, fossil fuels and petroleum molecules can exit the soil due to these leaks. Tar, asphalt, and bitumen are collected by these leaks. The primary fossil fuel found in oil sands is bitumen. A mixture of bitumen and asphalt is used to pave roads. The adhesive quality of bitumenjoins all the parts without changing their properties. Bitumen may adhere to a solid surface in a fluid state, depending on the surface. A coating of water inhibits adhesion. In the control sample, bitumen content is restricted at 3.8%. The bitumen utilized was 60/70 grade.

2.3. SBR Latex

Facilitate the components' copolymerization, a process in which single-unit molecules join to form longer, multiple-unit molecules, a soap-like surface-acting agent is employed to emulsify or disperse the components in a water solution. Stabilizers andfree-radical initiators are also present in the solution, both of which are required for the polymerization process to commence. Following polymerization, the polymer chain displays a random configuration of repeating Styrene or butadiene units. The polymer chains are connected during the vulcanization process. Recycled pavement aggregates have not only increased waste recycling but also reduced building expenses. Because of the significant impact that the aggregates had during their lives and they were a part of the original pavement, the recycled pavement has different mechanical properties. Recycled pavement aggregates that are smooth could cause a bonding problem. The water absorption and other crucial factors influence the recycled pavement aggregates' outstanding mechanical properties and long-term splitting tensilestrength. SBR latex is added to asphalt that contains recycled pavement aggregate at percentages of 5%, 10%, and 15% of the total bitumen volume.

Following are the steps explained in the flowchart by which the whole research was done.

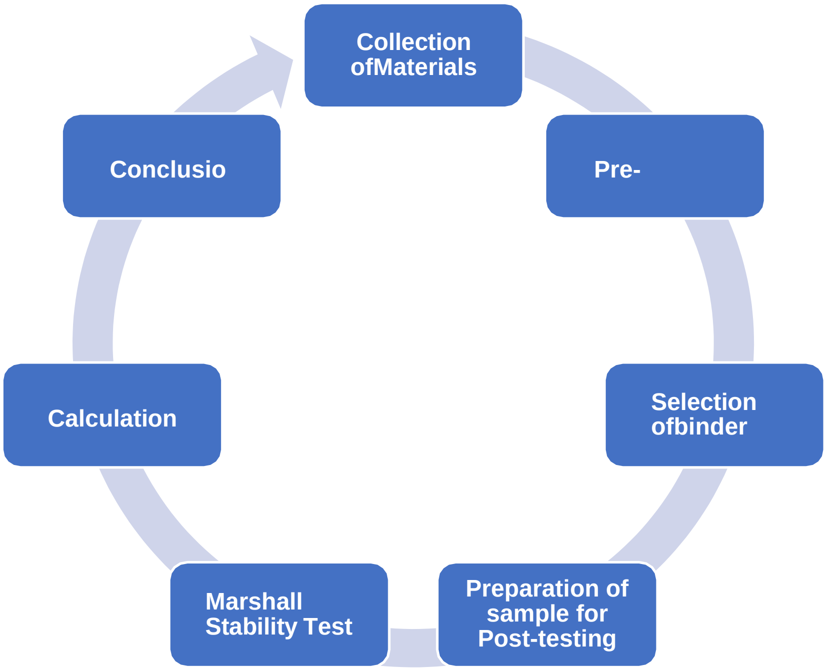

Figure 1: Methodology of Chart Diagram

3. RESULTS AND DISCUSSION

Following are the results of the different investigations done on the samples.

3.1. Sieve Analysis of Asphalt Mix Aggregate

Table 1: Gradation calculation of recycled asphalt mix aggregates

Sieve size (inch)	Sample 1 Cumulative Retained (grams)	Retained (%)	Passing (%)	Sample 2 Cumulative Retained (grams)	Retained (%)	Passing (%)	JMF limits
1 1/2"	0	0	100	0	0	100.0	
1"	0	0	100	0	0.0	100.0	**100**-100
3/4"	32.2	1.5	98.5	0.0	0.0	100.0	**90-100**
3/8"	805.5	37.4	62.6	665.0	27.8	72.2	**56-80**
# 4	1143.6	53.1	46.9	1062.1	44.4	55.6	**35-65**
# 8	1486.1	69	31	1504.6	62.9	37.1	**23-49**
# 50	1856.5	86.2	13.8	2035.6	85.1	14.9	**5-19**
# 200	2052.5	95.3	4.7	2255.7	94.3	5.7	**2-8**
Total	2153.7			2392.0			

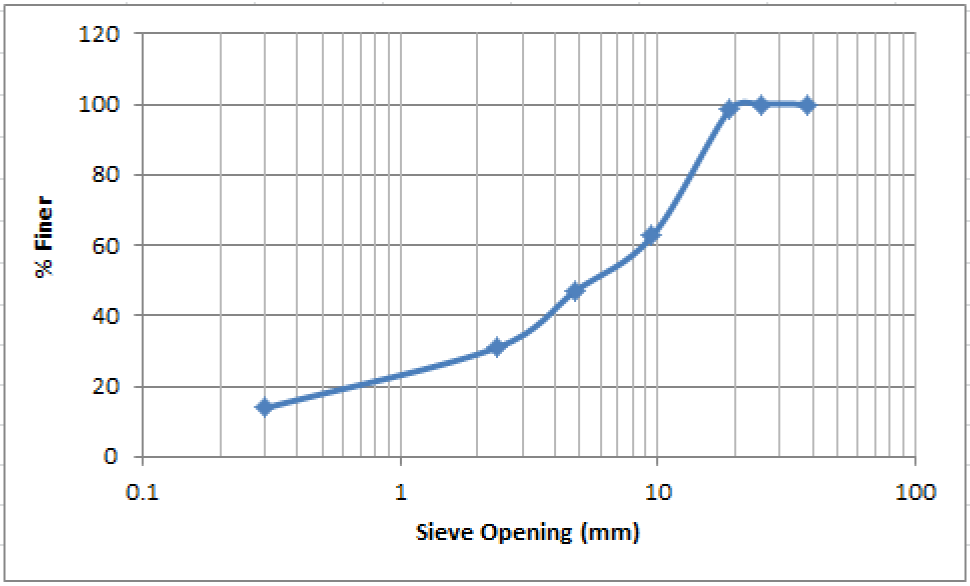

Figure 2: Gradation curve of recycled asphalt mix aggregate (Sample-1)

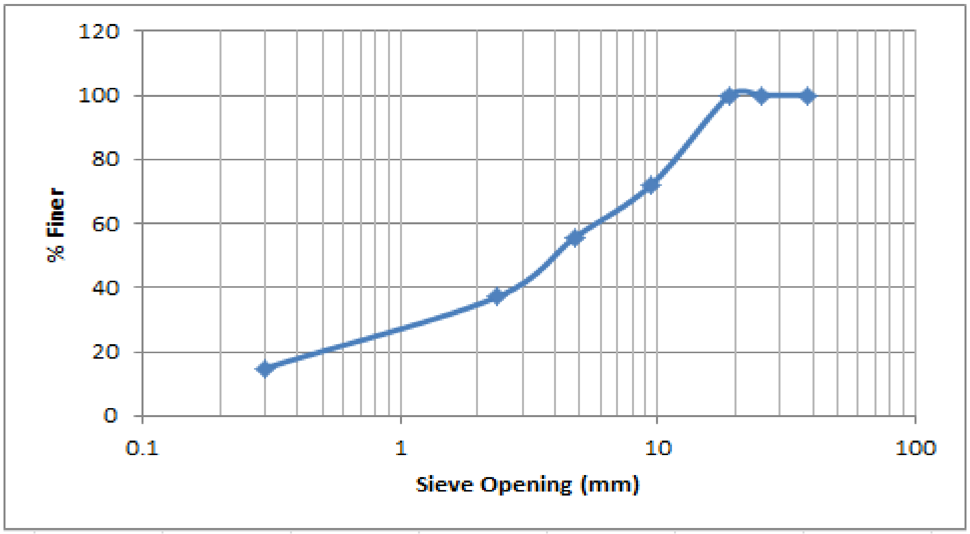

Figure 3: Gradation curve of recycled asphalt mix aggregate (Sample-2)

3.2. Bulk Specific Gravity for Aggregate

3.2.1. Recycled aggregate

Following are the results of the bulk-specific gravity calculation for recycled aggregate. W1 represents the initial sample weight. W2 is the sample's weight following an 18-hour soaking in water and subsequent pet drying. The sample's weightin water is W3.

Table 2: Calculation of absorption and bulk-specific gravity of Recycled Aggregate

Sample	Weight W1 (grams)	Weight W2 (grams)	Weight W3 (grams)	Bulk specific gravity	Absorption
01	1001	1021	581	2.31	2.3
02	1001	1019	603	2.42	1.82
03	1001	1024	613	2.431	2.31

3.2.2. Normal aggregate

Following are the results of the bulk-specific gravity calculation for normal aggregate.

Table 3: Calculation of bulk specific gravity and absorption of normal Aggregate

Sample	Weight W1 (grams)	Weight W2 (grams)	Weight W3 (grams)	Bulk specific gravity	Absorption
01	1001	1017	616	2.52	1.62
02	1001	1011	623	2.571	1.1
03	1001	1014	626	2.63	1.31

4. DISCUSSION

Compared to regular aggregate, recycled aggregate absorbs more water. Recycled aggregates absorb water at a rate of 2.6% to 5.6%. and the typical aggregate falls between 1.4% and 1.7%. Additionally, prior research indicates that recycled aggregate absorbs more water than regular aggregate. According to Rahal, K. (2007), recycled aggregate absorbs 3.5% more than regular aggregate. The range is 2.8 to 5.9. Recycled aggregate has a lower bulk specific gravity than regular aggregate. The normal aggregate range is 2.6, but the regenerated aggregate ranges from 2.3 to 2.6. While prior research has given us bulk-specific gravity values of 2.5–2.6 for conventional aggregate and 2.3–2.5 for recycled aggregate, it varies from 2.6–2.7. Yehia, Sheriff (2016).

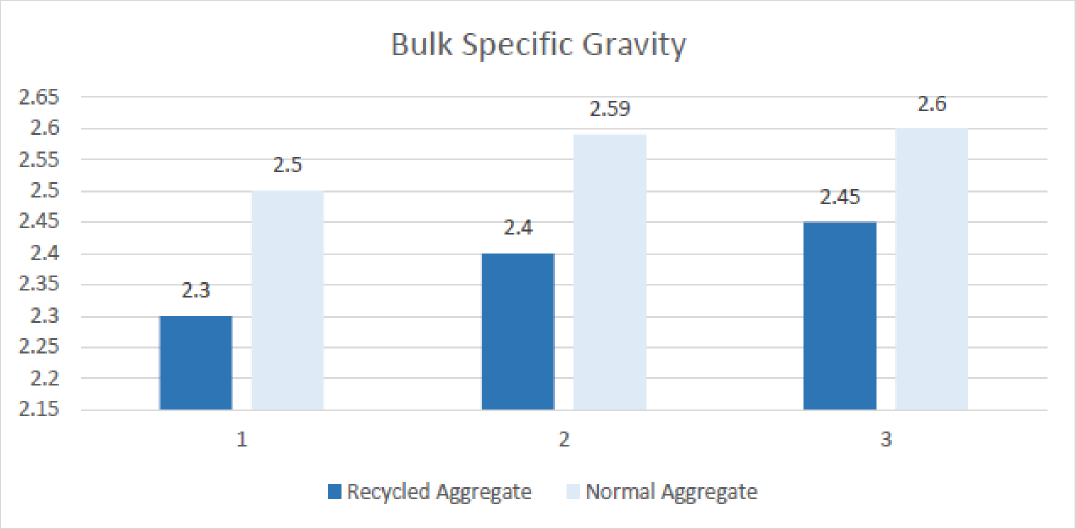

Figure 4: Comparison of bulk-specific gravity of recycled aggregate and normal aggregate

The bulk-specific gravity varies in each of the three samples, which include recycled and regular aggregate. Recycled aggregate has a bulk-specific gravity that fallsinside the range.

4.1. Los Angeles Abrasion Test

Recycled aggregate performs worse than normal aggregate. It breaks off readily because of the motor, which covers the aggregate. For recycled aggregate, the percentage loss ranges from 25% to 35%. And for a typical aggregate is 19 to 25%.

4.1.1. Recycled aggregate

Three samples are taken for the Los Angeles abrasion test. Let's assume a 5000gstarting sample weight. W2 is the sample weight following the machine's revolution. We determine the percentage of aggregate loss following testing by using the algorithm.

Table 4: Calculation of the percentage Los of recycled aggregate

Sample	Weight W1 (grams)	Weight W2 (grams)	Percentage Loss (W1-W2)/W1*100
01	5001	3641	27.41
02	5001	3801	24.2
03	5001	4109	17.841

4.1.2. Normal aggregate

In this case, normal aggregate is used in place of recycled aggregate. Three samples have been taken. There is 5000g in the beginning. W2 is noted in column 3 following testing. The algorithm listed in column 4 is used to determine the percentageof loss.

Table 5: Calculation of abrasion value of normal aggregate

Sample	Weight W1 (grams)	Weight W2 (grams)	Percentage Loss (W1-W2)/W1*100
01	5001	4371	12.61
02	5001	4451	11.1
03	5001	4346	13.12

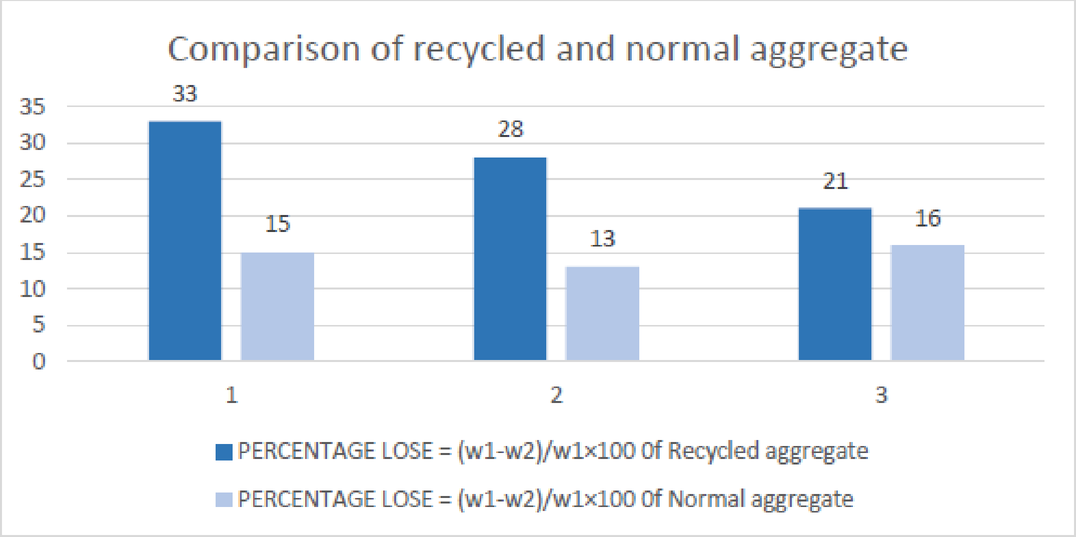

Figure 5: Comparison graph of abrasion value of normal aggregate and recycled aggregate

The above figure makes it clear that recycled aggregate has a higher proportion of loss than normal aggregate. Because recycled aggregate undergoes loading, it has a higher crushing value than normal aggregate. Sheriff Yehia (2016) found that for recycled aggregate, the loss angles abrasion values range from 25 to 35% based on prior research. as well as 19–25% for a typical aggregate. In contrast, this study shows that recycled aggregate has a higher abrasion value than normal aggregate. Compared to normal aggregate, recycled aggregate has an abrasion value that is 44.4% higher.

5. Centrifuge Extractor

The bitumen extractor test, or ASTM D2172, states that this test uses the cold dissolving method to determine how much bitumen (or asphalt) binder is utilized in the asphalt pavement. The bitumen content utilized determines the asphalt pavement's strength, durability, and quality. Use any authorized cold solvent.

Table 6: Calculation of extraction of bitumen content

Serial No.	Description	Values
1	Weight. of Mix Sample: (grams)	2238.9
2	Weight. of Filter paper before the test: (grams)	35.3
3	Weight. of Filter paper after the test: (grams)	39.7
4	Weight. of Filler: (grams)	4.3
5	Weight. of Aggregate after Test: (grams)	2149.6
6	Total Weight of Aggregate after Test + Filler: (grams)	2153.8
7	Weight. of Bitumen: (grams)	85.12
8	Percentage of Bitumen By Weight of Mix: (%)	**3.81**
9	J.M.F Tolerance:	± 0.3

The centrifuge extractor test yielded a bitumen concentration of 3.80% for the aggregate. 3.8% of the sample taken from the running road is made of asphalt. Job mix formula (J.M.F) tolerance for the centrifuge extractor test is ± 0.3.

6. Void Ratio

SBR is used at 0%, 5%, 10%, and 15%. It is also sampled using a normal aggregate. In row 1, bitumen is 3.8% and the aggregate use percentage is 96.2 for 0% SBR. SBR + Bitumen is 4% and the aggregate percentage for 5% SBR is 96%. In the same way, computed for others.

Table 7: Void ratio calculation of all mixes

Description	0% SBR Latex	5% SBR Latex	10% SBR Latex	15% SBR Latex	Normal Aggregate
Percentage of aggregate by total weight of mix (Ps)	96.1	95	95.9	95.7	96.2
Asphalt content byweight of mix % (Pb)	3.9	4.0	4.1	4.3	3.8
Voids % = Va = 100x(Gmm- Gmb) Gmm	7.5	6.7	5.8	4.5	6.3

The void ratio of the sample is calculated by applying the formula, which allows us to examine the sample's behavior and determine how many voids are covered. To enable comparison, we plot the recycled aggregate graph alongside SBR 0%, 5%, 10%, 15%, and normal aggregate. The sample with a varying void ratio is shown in the figure.

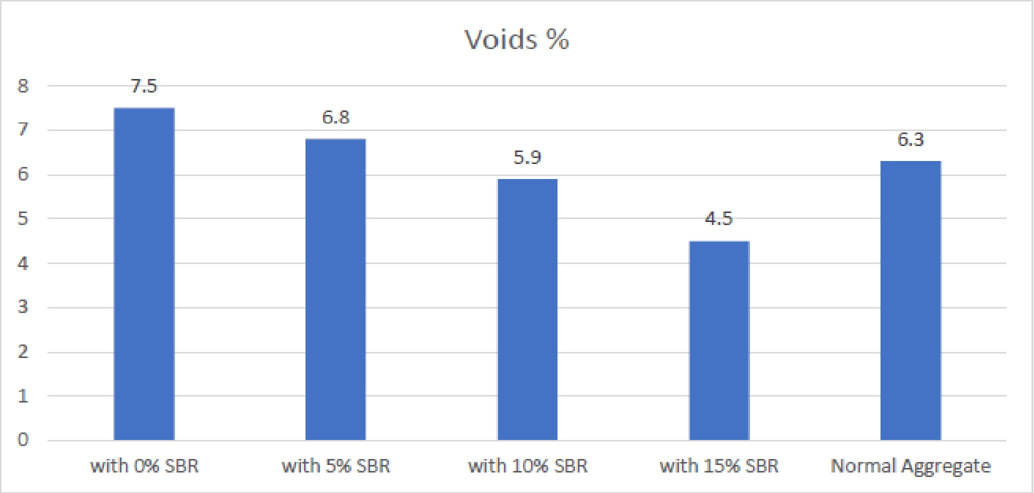

Figure 6: Graphical representation of the void ratio

The table illustrates that as we raise SBR% from 0–10%, Gmb increases and the void ratio decreases. As SBR increases by 10% to 15%, the void ratio decreases.

7. Marshall Stability

Thepurpose of this test is to determine the ideal binder content for the mix type and trafficvolume.

Table 8: Calculation of stability of recycled asphalt aggregate sample with0%, 5%, 10%, and 15% SBR and normal aggregate

	Stability	**20 min**			**30 min**			**24-hours**		
0% SBR Latex	Measured	70	71	72	68	69	67	63	60	62
	Adjusted = value*ring factor	1678	1702	1726	1630	1654	1606	1510	1438	1486
	Average (kg)	1703			1631			1479		
	Loss of stability	13.3								
5% SBR Latex	Measured	83	82	84	73	76	75	71	68	68
	Adjusted = value*ring factor	1965	1932.0	1946.0	1775	1788.0	1760.0	1679	1664.0	1664.0
	Average (kg)	1959			1775			1663		
	Loss ofstability	15.4								
10% SBR Latex	Measured (kg)	93	89	91	86	85	86	76	77	77
	Adjusted = value*ring factor	2206	2119.0	2167.0	2038	2023,0	2047.0	1799	1832.0	1832.0
	Average (kg)	2157			2029			1814		
	Loss of stability (%)	15.9								
15% SBR Latex	Measured	71	73	72	85	84	85	56	56	55
	Adjusted = value*ring factor	1702	1750	1726	2037	2013	2037	1342	1342	1318
	Average (kg)	1726			2029			1334		
	Loss ofstability (%)	22.7								
Normal Aggregate	Measured (kg)	56	63	63	61	60	58	54	52	56
	Adjusted = value*ring factor	1558	1510	1534	1462	1438	1390	1294	1246	1342
	Average	1534			1430			1294		
	Loss of stability	15.6								

The ring factor for the Marshall Stability test is 23.97. As indicated in the table, the sample's stability after 20 minutes, 30 minutes, and 24 hours in the water bath was measured. The recorded stability value was later multiplied by the ring factor and finally the stability average. In addition, the percentage of stability lost was calculated by dividing stability at 20 minutes and by stability after 24 hours.

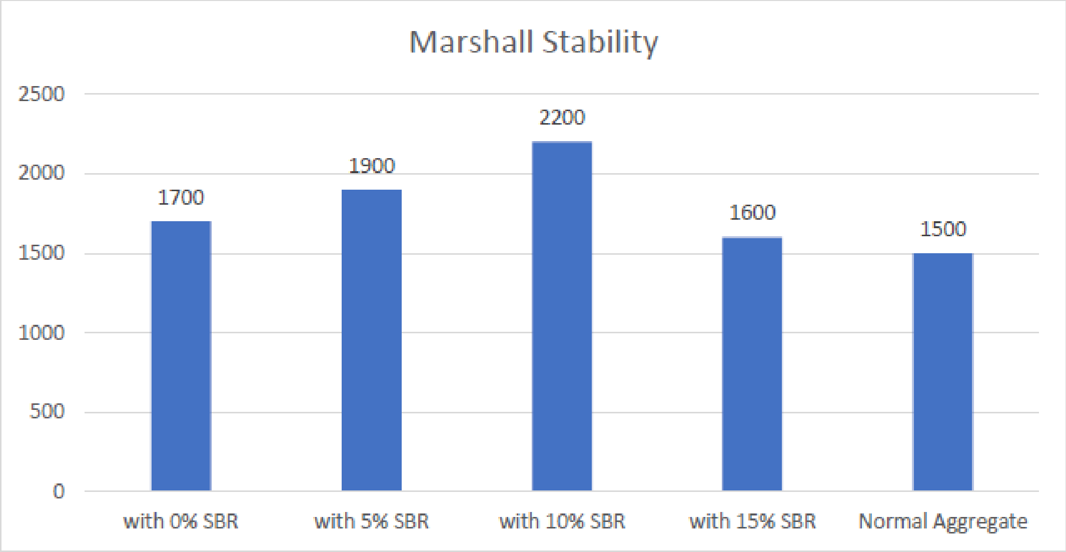

Figure 7: Graphical representation of marshal stability

The table shows that stability increases as SBR% increases from 0% to 10%, but stability begins to decline as SBR% increases from 10% to 15%. Additionally, the loss of stability was determined for every sample with a variable SBR%. According to Byung Jae Lee's 2015 research, the ideal mixture for cold recycledasphalt is 4% NCB non-cement binder, 3% asphalt, and 20% SBR. He discovered that, regardless of kind, marshal stability rises as filler content increases. The stability of SBR10, 20% emulsifier marshal increases.

8. Flow Value

A method forcharacterizing the rutting of a hot mix asphalt mixture empirically is the flow number. Take notice of the sample's flow value for normal aggregate and SBR of 0%, 5%, 10%,and 15%.

Table 9: Calculation of flow value of recycled asphalt aggregate sample with 0%, 5%, 10%, 15% SBR, and normal aggregate

	30 mints			Average/0.25
0% SBR Latex	2.41	2.21	2.31	9.21
5%SBR Latex	2.41	2.31	2.41	9.51
10%SBR Latex	2.41	2.51	2.41	9.71
15%SBR Latex	2.51	2.61	2.51	10.11
Normal Aggregate	2.21	2.11	2.31	8.81

The table shows that the flow value is recorded for every sample. Flow value is obtained after the sample is submerged in water for thirty minutes, and an average is then calculated.

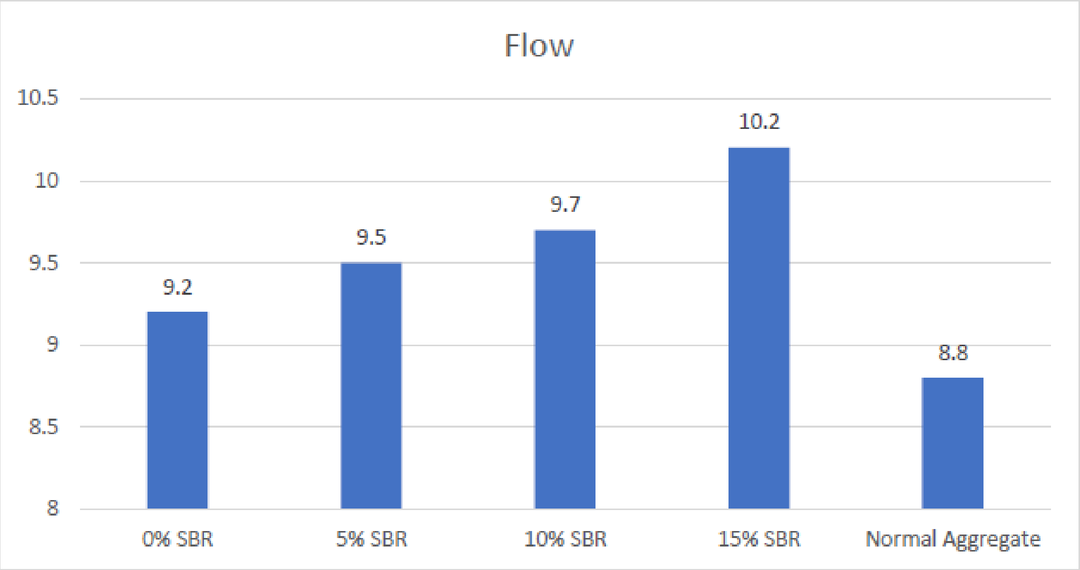

Figure 8: Representation of flow value of all mixes ring factor for Marshall Stability test is 23.97

CONCLUSION

These assessments are based on lab-based experiments. Every experiment is carried out in a controlled environment.

Following are the conclusion points of the research study.

- Normal aggregate and recycled asphalt aggregate sieve analyses fall within the JMF bounds of the job mix calculation.
- Compared to regular aggregate, recycled aggregate can absorb more water.
- Because recycled aggregate is more abrasive than regular aggregate, it crushes more quickly.
- Normal aggregate has a lower bulk specific gravity (Gmb) than recycled asphalt aggregate with SBR, although their maximum specific gravity is almost equal.
- Normal aggregate flow is lower than recycled asphalt aggregate with SBR, even when stability is within acceptable norms.
- To recycle the aggregate. To fortify the recycled asphalt mixture, SBR is employed. For SBR, different percentages of 0.5, 10%, and 15% are used.
- According to the preceding findings, Gmb grew when SBR% was raised from 0% to 10%. As we increased the SBR% Gmb more, the void ratio reduced.
- The marshal stability test leads us to the conclusion that 10% is the ideal SBR value. Value at 15% is OK, but it's getting close to the 25 limit. We therefore use 10% SBR optimal content.
- We concluded that adding SBR could potentially enhance the recycled asphalt aggregate mix's strength, flow, and stability. Repurposed asphalt aggregate can be put to use. To get the highest strength, we can add SBR% of bitumen content by developing it for the binder coarse using a sample from the main wearing coarse.

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