

SBR Latex Admixture: Effects on Sound, Water Absorption and Strength of Concrete

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Abstract

Malaysia is one of the countries that produces the world's highest of natural rubber latex and since 2001, has become as one of the leading global producers and played a significant role in the rubber industry across Southeast Asia. However, it was found that the demand of natural rubber latex in recent years fluctuated and was affected by the selling price becoming non constant and occasionally the selling price is lower than the investment cost. Therefore, to resolve these issues sustainably, this research was conducted related to applying, using and demanding natural rubber latex in the construction industry materials. Due to that, the study admixture of natural rubber latex in concrete materials was carried out. The aim of this research is to study the effect of applying admixture of natural rubber latex of 15%, 20% and 25% in standard concrete mixture - Grade 20, for the effect of sound absorption, waterproof absorption and compression tensile strength quality. The result shows, more percentage of latex admixtures means the better for soundproof absorption. Furthermore, the more percentage admixture of latex means the less water absorption arose. Lastly, concrete with admixture of 15% latex is the highest compression strength tensile compared with standard and other percentage of latex admixtures.

Key Words: Latex, Sound, Water Absorption, Concrete Strength

1.0 Introduction

Malaysia is one of the countries that produces the world's highest of natural rubber latex or styrene butadiene rubber (SBR) and has played a key role in the Southeast Asian rubber industry since 2001. As of 2023, Malaysia ranked as the eighth-largest producer of natural rubber latex in the Asia-Pacific region, contributing approximately 1.7 billion Malaysian Ringgit to the nation's gross domestic product (GDP) (Malaysian Statistics, 2025). However, it was found that the demand of natural rubber latex in recent year was fluctuated and was affected the selling price become not constantly and occasionally the selling price are lower than the investment cost. Therefore, to resolve these issues sustainably, this research and innovations was conducted that related in using and demanding of this natural rubber latex. Not to be denied, the construction industry is one of the fields that could consume a high demand of material usage, and as for example is the concrete works which is amongst the highest usage materials in construction industry (Jakrapa et.al., 2021). Due to that, the research of using natural rubber latex in concrete materials is urgently required.

Concrete is a demanding and common material useful in the construction industry throughout universal and also in Malaysian construction industry, since it's played a very importance component materials compared to other types of building materials. In this study, the researcher will apply an innovation which the researcher will used Latex as an additional mixture material to the existing current concrete mixture. Even though, the concrete has a high compressive strength as its major properties, but it's always been used together with reinforcing steel. Its impervious behaviour is also quite low and less sound absorption, structural components strength, deformability, adhesion etc (Ismail et al.,2009). Indeed, there are still some setbacks, some concretes have a low tensile strength, low ductility, high porosity, and low resistance to chemical attacks, and at that point an alternative admixture came into picture as called concrete modifier (Pilai et al.,2016). Nonetheless, to understand concrete behaviours it's must also to understand towards workability, flexural strength, durability qualities, tension, split tensile strength etc (Akula et al., 2024). Hence, in this study, the researcher has limited the study to 3 major areas only. The objective of this study is to investigate the effects of incorporating Styrene-Butadiene Rubber (SBR) latex as an admixture in a standard concrete mixture (1:2:4 - grade 20) for sound absorption, water proofing and strength quality that are

either the result is better, applicable and suitable for the concrete demand and requirement of Malaysia's construction industry. By then, the result of this research would serve some important information of applying SBR latex in concrete works mixture to increase some advantages and decrease unnecessary issues in future.

2.0 Material and Terms

2.1 Materials

The materials used consist of cement, aggregates, sand, water and latex as described in detail belows are:

2.1.1 Cement

This study utilized Ordinary Portland Cement (OPC), named for its resemblance to Portland stone in appearance. OPC is produced by heating a finely ground mixture of clay or shale and chalk or limestone in a kiln at approximately 1500°C, allowing chemical reactions to occur between the materials. After the formation of clinker, around 5% gypsum (calcium sulphate) is added to regulate the setting process and prevent flash setting. The final step involves grinding the mixture into a fine powder suitable for use in concrete.

2.1.2 Aggregates

Durability is not solely determined by the quality of the cement paste matrix. This issue has unfortunately become evident and is often attributed to reactions between alkalis and certain components within the aggregates. Aggregates, which serve as essential raw materials in concrete, are derived from natural sources and are typically extracted from pits and quarries. These materials include gravel, crushed stone, and sand. Aggregate must contain a critical proportion of the reactive aggregate for concrete:

- i. Significant cost reduction.
- ii. Minimization of shrinkage.
- iii. Improved fire resistance,

Size in range between of 12 mm and 20 mm coarse aggregate were used for mixture concrete preparation. The aggregates are tested as per IS code. The fineness modulus of 12 mm and 20 mm coarse aggregates are 1.45 and 1.93 and the specific gravity 2.51 and 2.77.

2.1.3 Sand

Sand used in concrete production is typically composed of materials such as gneiss, trap rock, limestone, or granite. This type of sand is specifically manufactured for concrete applications. It is generally crushed at the quarry, then washed and screened to ensure high quality. The result is a coarse-textured material, produced through meticulous processing that removes impurities and enhances its suitability for use in concrete mixtures. This process will make sure that there are no large rocks within the materials. It is most used to as a key ingredient in cement or hot asphalt but can also be used as pipe sand or as a base layer and levelling medium for above ground pools, and patio or walkways made of concrete paving stones. In this study, the size of 0.6mm of sand (fine aggregate) was used in the experiments. It's specific gravity of 2.75

2.1.4 Water

Water is a critical component in concrete production, as it actively participates in the chemical reaction with cement to form the strength-producing cement gel. Therefore, both the quantity and quality of water must be carefully evaluated. In practice, while significant attention is often given to controlling the properties of cement and aggregates, the quality of water is frequently overlooked. However, since water quality directly influences the strength and durability of concrete, its purity should not be neglected. Impure water, particularly water that causes staining, is unsuitable for curing concrete elements where appearance is important.

The most common cause of staining in concrete is a high concentration of iron or organic matter present in the water. In general, water that is suitable for mixing is also acceptable for curing. The chemical reaction between water and cement, known as hydration, begins when Portland cement is combined with water. This reaction is essential to the development of strength in concrete and is considered substantially complete after 28 days. Hydration depends on the availability of moisture. When water is added to cement, it forms a fluid paste that gradually becomes stiff and eventually hardens—a process known as setting. While using less water generally results in stronger concrete, an adequate amount is still required to ensure a workable mix that can be efficiently mixed, placed, compacted, and finished without complications.

2.1.5 Natural Rubber Latex (Resin Latex)

The term latex commonly refers to natural rubber latex, especially in its non-vulcanized form. Latex is produced by specialized cells called laticifers, which make up what is known as the lactiferous system. This system can develop in two distinct ways: in many plant species, it originates from rows of cells formed in the meristematic regions of stems or roots. Latex is typically a milky, white fluid found in various seed plants, including those from the milkweed, spurge, and poppy families. It serves as the natural source of materials such as rubber, gutta-percha, chicle, and balata.

Latex refers to a water-based emulsion of synthetic rubber or plastic, typically produced through polymerization, and is widely used in products such as paints and adhesives. In its natural form, latex is a milky fluid found in about 10% of all flowering plants. This fluid is a complex emulsion composed of proteins, alkaloids, starches, sugars, oils, tannins, resins, and gums, which coagulate when exposed to air. Natural latex is usually exuded from plant tissues as a response to injury.

In this study, a latex-based admixture was used to enhance both the fresh and hardened properties of latex-modified concrete. The admixture, identified as Latex-108, is a new-generation product formulated from modified polycarboxylic compounds. It is a liquid admixture that interacts with cement particles in the mix, functioning as both a high-performance plasticizer and a deflocculating agent, while also providing controlled setting retardation. The specific gravity of latex was recorded as 1.023. Details of latexes used:

Table 1: Styrene Butadiene Rubber (SBR) Latex

Type	Form
Styrene butadiene rubber	White Liquid
Density	1.08 kg/L at 25°C
Solid Content	45%
Hydrogen content (CHNS test)	8.68
PH value	8

2.2 Admixtures

The basic concrete mix design can be enhanced by admixtures. Admixtures are defined as materials added to concrete or mortar, other than Ordinary Portland Cement, aggregates, and water, either before or during the mixing process. While proper concrete mixing practices typically ensure that the resulting concrete meets performance requirements, certain situations may call for the use of different types of cement or modifications to the mix design. Such changes can be made to tailor specific properties for specialized applications or service conditions. Below is a table of concrete admixtures by classification.

Table 2: The Concrete Admixtures by Classification

Types of Admixtures	Desired effect	Material
Bonding mixture	Increase Bond Strength	Polyvinyl chloride (PVC), Polyvinyl acetate (PVA), Acrylics, and Butadiene-Styrene Copolymers

However, it is important to consider when modify the design, by applying, for one or more of the following purposes:

- i. To enhance durability of hardened concrete.
- ii. To accelerate setting time.
- iii. To improve the workability of fresh concrete.
- iv. To reduce water content, by increasing strength water-cement ratio.
- v. To improve concrete resistance to extreme temperatures, freezing and heat.
- vi. To certify volume stability by minimizing shrinkage during the curing process.

3.0 Experimental Works

Not to denied that the most basic material used in building construction development in Malaysia is concrete. Without concrete, the construction is not strong enough to afford and bear large loads. In fact, the building is easily collapse with only a small earth movement or overloads. Therefore, by applying the right material of concrete mixture modifications, concrete can be enhanced and reinforced by its structure to become more robust, durable and withstand in trouble as well as accelerating construction time (Aan et al.,2016). In this study, the experimental was carried out with SBR latex was added/ mixed to standard concrete mixture (1:2:4 – Grade 20) with composition containing of 10%, 15% and 20% by weight of cement were prepared. This grounded-on weightage of cement as similarly ordinary formula used by previous researcher (Akshara et al.,2017). Sample of concrete cubes measuring 150 mm × 150 mm × 150 mm were cast using latex-modified admixture concrete for the purpose of conducting compressive tensile strength and water absorption tests.

The size of 440mm x 215mm x 100mm size of sample concrete block mould was prepared for the experimental sound exercise purposes. The study was applying a triangular

experimental design by making 12 numbers of concrete block samples to create three tests namely compaction, water test absorption, and sound test. Each of the sampling have a different percentage of latex admixture and contained of 4 samplings.



Figure 1: Concrete mould (440x215x100mm)



Figure 2: Aggregate, sand, cement and SBR latex



Figure 3: SBR latex – 108



Figure 4: Mould with concrete admixture sampling



Figure 5: Sample of ready concrete block



Figure 6: Sound Meter Level tool



Figure 7: Conducting water absorption curing



Figure 8: Conducting strength compaction test

3.1 Specimen Preparation and Experimental Conductions

Batching and mixing were conducted in accordance with MS EN 934/BS EN 934-2 (JKR 20800-0183-14_Pindaan_January 2014-Concrete Works). The mixture concrete was prepared by standard concrete grade 20 (1:2:4-20mm aggregate) which consists of cement, sand, aggregate, water and the latex used is added to the mixing water. The percentage of admixture latex was mixed accordingly as 0%, 15%, 20% and 25%. Total of 12 numbers of concrete mould was ready and prepared. All the mixture concrete moulds were kept in 30°C temperature or in normal laboratory condition and cover with wet burlap for 24 hours. After further drying 24 hours, the mould was removed, and the specimens was immersion in water at temperature of 23°C. All the specimen's solution periods are 7, 14 and 28 days.

3.2 Specimen Testing

At the end of solution immersion periods (7, 14, 28 days), specimens were tested for sound absorption, water absorption and strength compaction. All the specimens were test following the Malaysian Standard (MS) specification by Department of Standard Malaysia (MS EN 1992-1-1:2004, Eurocode 2).

Measurement of sound absorption was conducted in accordance of MS 27-MS 922 (code of sound). The measurement test tool used was a Sound Level Meter, designed to meet the requirements of safety engineers, the industrial health sector, and quality control across a wide range of industrial environments (Figure 5). Whereas, the water absorption test was conducted in accordance with MS 881(Water Absorption Test) to determine the percentage of water absorbed by the concrete after following the scheduled curing procedure (Figure 6). Finally, the compressive strength test was performed based on the guidelines outlined in MS 1056 (Compaction in Strength Test) by using a compression factor test machine, which measures the compatibility of concrete by allowing it to fall from a standard height under controlled conditions (Figure 7).

4.0 Result and Analysis

3 tests have been conducted in different ratios of latex percentage in 3 different period of days in within 7, 14 and 28 days respectively. The data analysis was carried out for evaluating by using analytical and logical reasoning to examine each component or data provided. The decisive goal is to be discovering useful information, analysis solving, facts discovering and conclusion to support the critical decision making towards conducting research experiments.

4.1 Sound Absorption Test

Figure 8 shows the comparison of water absorption test between normal concrete and latex mixture with addition 15%, 20% and 25% of latex at a day of the 28 days.

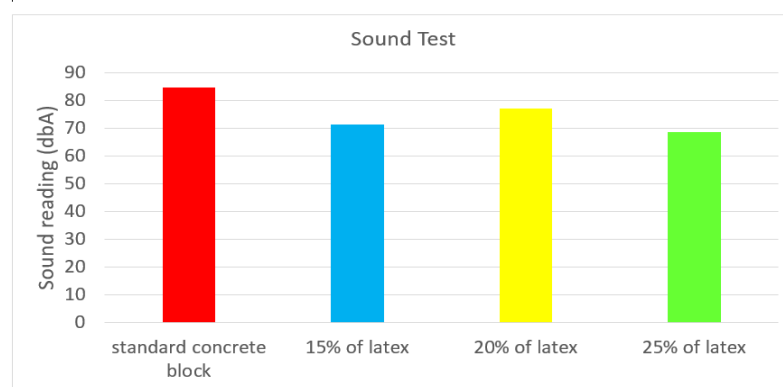


Figure 9: Effect of latex admixture in sound absorption tests

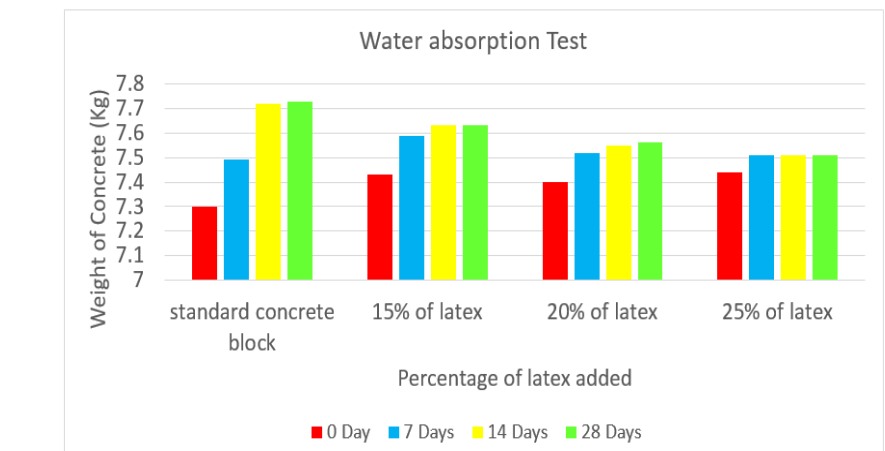
Table 3: Comparison between all the data of effect sound absorption tests

Type of concrete block/Percentage	Average of result (dB)
0%	84.83
15%	71.33
20%	77.10
25%	68.50

A Sound Level Meter is a measuring instrument used to assess noise or sound levels by detecting sound pressure. Commonly referred to as a decibel (dB) meter, noise meter, or noise dosimeter, it functions by using a microphone to capture sound waves. The captured sound is then processed within the device, and the acoustic measurement values are displayed on the screen of the meter for analysis. The smaller figure of dB result means the better sound absorption of the materials tested.

Figure 8a & 8b, indicated that data that obtained by concrete block with 0% latex have the highest result compared to others which is 84.83 db. While the second highest is concrete block with 20% latex which is 77.10db. The concrete block with 15% latex attained 71.33db of average result. Finally, the lowest of average result in sound test is concrete block is contained with 25% latex. Therefore, from the result, we can conclude that concrete block with contained of 25% latex have a least absorb of sound. Therefore, the concrete block of 25% of latex is the best among the others.

4.2 Water Absorption Test

**Figure 10:** Effect of latex admixture in water absorption**Table 4:** Effect of latex admixture in water absorption

Percentage/ Result/ Days	0	7	14	28
0%	7.30kg	7.49kg	7.72kg	7.73kg
15%	7.43kg	7.59kg	7.63kg	7.63kg
20%	7.40kg	7.52kg	7.55kg	7.56kg
25%	7.44kg	7.51kg	7.51kg	7.51kg

Refer to Figure 9 shows the comparison of water absorption between the normal and latex admixture of 15%, 20% and 25% respectively and in range period of testing from day's 7, 14 and 28. The figure shown that all type of sample concrete had an increasing absorption of water in between time gap indicated. Nevertheless, the percentage of the increasing is differently

amongst the sample. Finally, from the figure shown that the sample of standard concrete (0% latex) has absorbed the highest water level at the day of 28 by weighting of 7.73kg compared to others. The second higher of water absorption is sample with 15% of latex, thirdly by sample concrete of 20% of latex. The lowest water absorption of water goes to sample concrete with 25% of latex. This finding was to conclude that the concrete sampling with admixture of 25% of latex was the less water absorption in this experimental.

4.3 Compression Tensile Strength Test

2 tests were conducted on the concrete block samples at 14 and 28 days. Figures 10a, 10b, and 10c present the data and results obtained from the compressive strength test. Compressive strength is a critical mechanical property of concrete blocks, as it determines their load-bearing capacity and long-term durability. This property is influenced by factors such as the latex composition, manufacturing method, and curing process. The compressive strength was determined by capping and testing the specimens in a "flatwise" orientation, meaning the load was applied along the height of the unit, in accordance with ASTM C67. The compressive strength was calculated by dividing the maximum load at failure by the cross-sectional area of the specimen. Depending on the block geometry, either the net or gross cross-sectional area was used for this calculation. However, the net cross-sectional area was only considered when it constituted less than 75% of the gross area.

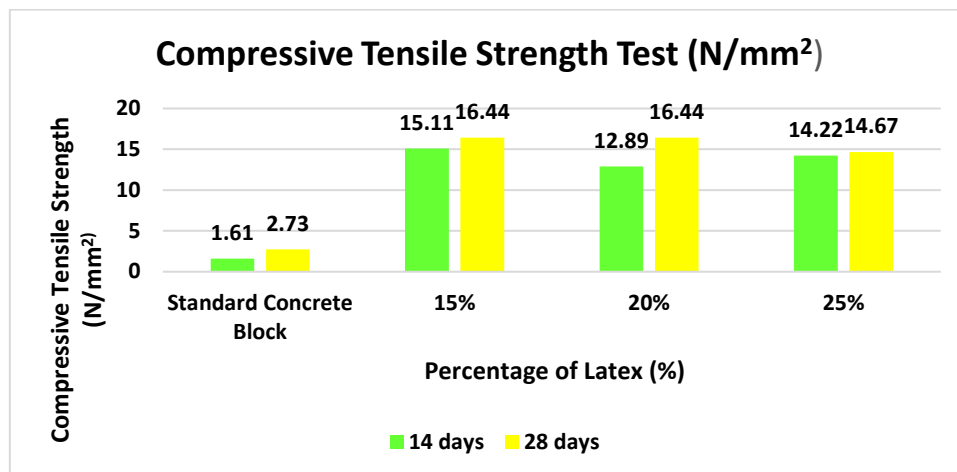


Figure 11: Overall sample concrete block 0, 15%, 20% and 25% the admixture of latex

Table 5: For 14 days, for standard concrete block, 15%, 20% and 25% the admixture of latex

SP. No	% latex mixture	Density (Kg/m3)	Density (kg)	Load (F) in kN	strength in compressive (N/mm2)
1.	0	2015	6.8	36.3	1.61
2.	15	2133	7.2	340	15.11
3.	20	2163	7.3	290	12.89
4.	25	2104	7.1	320	14.22

Table 6: For 28 days for standard concrete block, 15%, 20% and 25% the admixture of latex.

SP. No	% latex mixture	Density (Kg/m3)	Density (kg)	Load (F) in kN	strength in compressive (N/mm2)
1.	0	2015	6.8	61.4	2.73
2.	15	2133	7.2	370	16.44
3.	20	2281	7.7	370	16.44
4.	25	2104	7.1	330	14.67

The result obtained for sample concrete block compaction compression tensile tests for different admixture and days are shown in figure 10a, 10b and 10c respectively. Figure 10a, shows the overall results of compressive tensile strength test for concrete block consists of 0%, 15%, 20% and 25% admixture of SBR latex in days of 14 and 28. Whereas, figure 10b and 10c shows the detail result of each particular days of result were tested. Figure 10b, details for day's 14 result and figure 10c show the details of result details on days 28.

The results show that the original standard concrete with 0% of latex admixture resulted for days of 14 and 28 are, the Load (F) in kN is 36.3 and the compressive strength is 1.61 and Load (F) in kN is 61.4 and the compressive strength is 2.74 respectively. Therefore, the average of Load (F) in kN in standard concrete block of latex (0%) for 14 and 28 days is 48.85 kN and compressive strength is 1.96 (N/mm²). Whereas the results show for concrete with 15 % of latex admixture resulted for days of 14 and 28 are, the Load (F) in kN is 340 and the compressive strength is 15.11 and Load (F) in kN is 370 and the compressive strength is 16.44 respectively. This show that, the average of Load (F) in kN in standard concrete block of latex (15%) for 14 and 28 days is 355 kN and compressive strength is 15.78 (N/mm²).

Next, the results for concrete with 20% of latex admixture resulted for days of 14 and 28 are, the Load (F) in kN is 290 and the compressive strength is 12.89 and Load (F) in kN is 370 and the compressive strength is 16.44 respectively. The result shows that the average of Load (F) in kN in standard concrete block of latex (20%) for 14 and 28 days is 330 kN and compressive strength is 14.65 (N/mm²). Finally, the results show for concrete with 25 % of latex admixture resulted for days of 14 and 28 are, the Load (F) in kN is 320 and the compressive strength is 14.22 and Load (F) in kN is 330 and the compressive strength is 14.67 respectively. Therefore, the average of Load (F) in kN in standard concrete block of latex (25%) for 14 and 28 days is 325 kN and compressive strength is 14.45 (N/mm²). As a conclusion for the comparison compressive tensile strength test, the result shows that the all-admixture latex in indicated percentage had improved the strength-imposed load of concrete compared with standard concrete.

5.0 Conclusion

This study was focused on the effect admixture of 15%, 20% and 25% of cement weight by Styrene Butadiene Rubber (SBR) Latex in a standard mixture concrete of Grade 20 (1:2:4 – 20mm) and with different level days of test conducted (7, 14 and 28 days). Based on the result attained and the analysis carried out, thus, it was concluded that:

- i. The result for concrete sound absorption shows that the lowest sound absorption is standard original concrete mixture which received average results of 84.83 db (decibel) and the highest soundproof of sound absorption is a concrete with admixture of 25% latex with average results of 68.50 db. Therefore, the more percentage of latex admixtures means the better for soundproof absorption for concrete.
- ii. From the result and analysis done, it indicated that the highest water absorption is standard concrete mixture with average results of 7.30 kg on the first days and rose to 7.73 kg on the days of 28, increasing of 0.43kg of water contents. Whist the results show that the best ratio concrete block for less water absorption is concrete with admixture of 25% latex as additional ingredient. The concrete block with additional latex mixture absorbed amount of 0.07 kg of water from the days 1 to the of day's 28. This was indicated that the more admixture of latex means the less water absorption arose.
- iii. Finally, the compressive tensile strength test was conducted to identify and evaluate the maximum tensile strength of each type of concrete block. The result shows that the best and maximum load imposed on the sample were concrete with admixture of 15% latex is the highest compared with the standard and all other percentage of latex admixtures.

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