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Blown Bitumen Emulsion for bituminous roads in Wearing coat with Nano Calcite Composite

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Abstract

There are two different studies that are Blown Bitumen emulsion with nano calcite composite as wearing coat and cement concrete mix with miller silicate binder applying in potholes and crack fillings which gains higher strength. This study focuses on evaluating the strength of concrete mix, where up to 25% of is replaced with miller silicate binder. Compressive strength, Flexural strength were examined. The results indicate that replacing water content with miller silicate binder improves the mechanical properties of the concrete mix, including increased compressive strength and flexural strength. Specimens will be prepared and laboratory studies such as compressive strength and flexural strength are done on cement concrete mix for potholes. Field Tests such as skid resistance, mean texture depth and water seepage are proposed on blown bitumen emulsion composite nano calcite based wearing coat.

1. Introduction

The loss of adhesion between the aggregates and the binder due to the top layer failing as a result of vehicle impacts and water seeping into the pavements results in aggregate loss from the surface layer, which has an adverse effect on road users. It is evident that the vehicles are skidding, which causes accidents, some of which may even be fatal. This can be fixed by coating the surface with a thin wearing coat to increase adhesion and stop water from penetrating the pavement. Flexible pavement can experience a variety of failures, including different kinds of cracking, bleeding, ravelling, bumps, and rutting. Preventive measures must be taken for every type of distress.

The chip seal, overlay, slurry seal, and crack seal were found to be effective for pavement with more cracks, and it was discovered that the above methods should be used when the pavements are in good condition for pavement treatment maintenance to be effective. The components that are used to make seal coats were assessed by Sanjaya Senadheera et al (Jahren and Behling).

It was concluded that wearing coats has a very short average life on the interstate highways. It was found from the study that for the Kanas highway 2.5” overlay was found to be very effective with an average service life of over 6.5 years whereas for seal coat its 4.75 years (W Behrens).

1.1. Wearing coat

Analyse the effect on coating and insulation using emulsified modification bitumen (EMB) to address the issues. a deeper comprehension of the mechanisms at work to help design the best system possible for the sector (Razali et al.). Using simple test frameworks, emulsion application rates (EARs) in chip seal and tack coat applications can be determined on-site. Local in situ EAR measurements can be taken while building using the methods mentioned. For both tack coats and chip seals, the test methods identified allow for the calculation of the EAR from residual binder application rate measurements and the emulsion water content (Malladi and and).

The research into the use of nanomaterials for this widespread issue was motivated by studies showing the impact of additive particle sizes on the moisture resistance of bituminous mixes. This review's focus is on understanding moisture damage's mechanism and how nanotechnology can be used to stop it (Hamedi, Nejad, and Oveisi). Nano particles prevent moisture damage on the bituminous pavements which acts as a dominant factor in preventing most of the distress that is caused due to the seepage of the water. Nano particles added to blown bitumen emulsion increases the bond strength of the mix, reduces the water absorption, and improves the strength of the mix (Razavi and Kavussi). Nano calcite has enormous advantages when used as an additive in terms of enhancing the physical, mechanical, and chemical properties and has negligible disadvantages. This nano calcite can enhance the properties of blown bitumen emulsion at high, intermediate, and low temperatures resistant and increase the functional strength of the pavement and increases the serve life of existing surface (Sohrabi, Shirmohammadi, and Hamedi).

1.2. Cement concrete

Complementary cementitious materials (SCMs) have an impact on the compressive strength and chloride ion permeability of cement mortar with extremely low water to binder ratios (Panesar and Zhang). Following both dry and wet activation, the physic mechanical properties of quartz-cement stone are provided. The current work's objective is to investigate the physic mechanical characteristics of cement stone that has been filled with ultra-dispersed quartz (Hu et al.) .

A preliminary investigation into the potential use of quartz powder (QP) as a mineral admixture in place of Portland cement (PC) to withstand high temperatures and thermal shock was conducted. PC was swapped out for 0, 5, 10, 15, and 20 wt. QP. The different pastes that had hardened were subjected to high temperatures for two hours (De Matos et al.).

A recent Na-silicate binder with a liquid hardener's technological significance and suitability for use in a Mold/core system have been examined. Na-silicate binder has been found to have more significant advantages and benefits, including a shorter time required to apply CO2, a solid mould surface free of cavities, good gas permeability, and a prolonged shelf life in high moisture environments (Ünlü and Odabaş). This study examines the effects of substituting silica fume (SF) or a 20-m medium diameter quartz powder (QP) for 20% of Portland cement on the characteristics of cementitious composites from the earliest hours of hydration to a few months after curing. The findings show that QP has no pozzolanic activity while SF is pozzolanic. The use of SF and QP lowers the early energy released in comparison to the control paste, demonstrating that these materials lower hydration heat (Lin, Wang, and Yi-Han). Cementitious pothole filling system that is quick. It considers the theoretical aspects of cement setting and hardening, examples of the numerous admixtures that are known to act as concrete accelerators, superplasticizers, which are organic polymers that are water soluble, and high-alumina cement, a unique substance with hydraulic calcium aluminates as its primary component (Utomo and Primaswari).

2. Materials and Methods

A liquefied form of bitumen with a low viscosity is known as bitumen emulsion. Ordinary bitumen can be easily transformed into a low viscosity liquid that can be used in a variety of applications, such as repairing and maintaining roads, waterproofing, spraying, etc., by dispersing it in water and adding an emulsifier. Bitumen is easier to handle, store, transport, and apply. Blown bitumen emulsion is mixed with water with 1:1 ratio and 0.05 of acrylic solution and applied as wearing coat on bituminous roads. Silicate binder is a dilution, (Pavel et al.) was used as a replacement whose specific gravity value is 2.70 and it is used with varying different dosage with water content. Sodium silicate binders are commonly used for their high strength, good thermal stability, low cost, and low contamination. This chemical dilution was used in the mix design of M20 grade concrete which helps in enhancing the workability and helps in increasing the bond strength. Silicate binder compound formula is H2Na2O4Si, and it is a brown colour that can be easily mixed with water.

2.1. Materials used in Potholes Repairs.

Coarse aggregates of 20mm downsize were used as per specification of IS:383-2016. M sand was used as the fine aggregate by replacing the river sand, which was found to be economical (383). silicate binder was used in water with varying dosage percentages of 0%, 5%, 10%, 15%, 20%, to the weight of the cement. Mix Design of M 20 concrete carried out as per specification IS:10262-2019 and IS:456-2000 (10262).

TABLE 1. Physical Properties of Materials Used for Mix Design

Fine aggregates (M Sand)	
Specific Gravity of Fine aggregate	2.58
Water absorption	3.24%
Coarse Aggregate (20 mm downsize)	
Specific Gravity of Coarse aggregate 20mm	2.62
Cement	
Specific Gravity	3.12
Silicate binder	
Specific Gravity	2.7

Target mean strength of concrete at 28 days.
fck = 20+1.65 X 4.0= 26.60MPa

TABLE 2. Mix Proportion

Cement	Fine Aggregate	Coarse Aggregate 20 mm and 12 mm down	Water	Silicate binder
439 Kg/m^3	635 Kg/m^3	1123 Kg/m^3	209.22Lts	10%

3. Methodology

- For cement concrete mix the Coarse aggregates of 20mm downsize were used as per specification of IS:383-2016. M sand was used as the fine aggregate, which was found to be economical.
- silicate binder was used in water with varying dosage percentages of 0%, 5%, 10%, 15%, 20%, to the weight of the cement.
- Properties such as compressive strength and Flexural strength were studied at 1day, 3rd,7th, 14th and 28th day intervals for cement concrete specimens.

1. **Compressive Strength:** The compressive strength of concrete nix was evaluated using cubes of size 150mm*150mm*150 mm conforming to IS 516- 1959 (516).
2. **Flexural Strength:** The flexural strength of concrete mix was evaluated using cubes of size 100mm*100mm*500 mm conforming to IS 516- 1959 (516).

4. Results and Discussion

Cubes with measurements of 150mm x 150mm x 150mm were tested to determine the compressive strength of concrete mix specimens. The 3rd, 7th, 14th, and 28th day compressive strengths are shown in Figure 1. As a 10% dosage of silicate binder was applied, an increase in the specimens' compressive strength was seen. According to the proportions, the increase in compressive strength was of the order of 15%. Concrete specimens' compressive strength was reduced by further silicate binder dilution. Concrete specimens with 25% water replacement had a 22% reduction in strength for specimens with mix proportions. The 10% replacement mix has the highest strength among the variations- 21.6 MPa for the varying dosage of silicate binder. The 25% replacement mix appears to possess the least strength.

The flexural strength increased when silicate binder for replacement of 10% dosage respectively. The maximum values of flexural strength obtained were 3.82 MPa for concrete mix proportions respectively. Beams which were air cured and had a dosage of 10% silicate binder were able to achieve a strength of 2.93 MPa in 14 days which is 88.18% the required strength of 3.13 MPa.

4.1. Wearing coat

Blown bitumen emulsion of Grade 90 is mixed with 3% nano calcite, 0.05% acrylic solution to the weight of the blown bitumen emulsion and ensured that through mixing is done. Blown bitumen emulsion is diluted in water with 1:1 dilution. Tests were

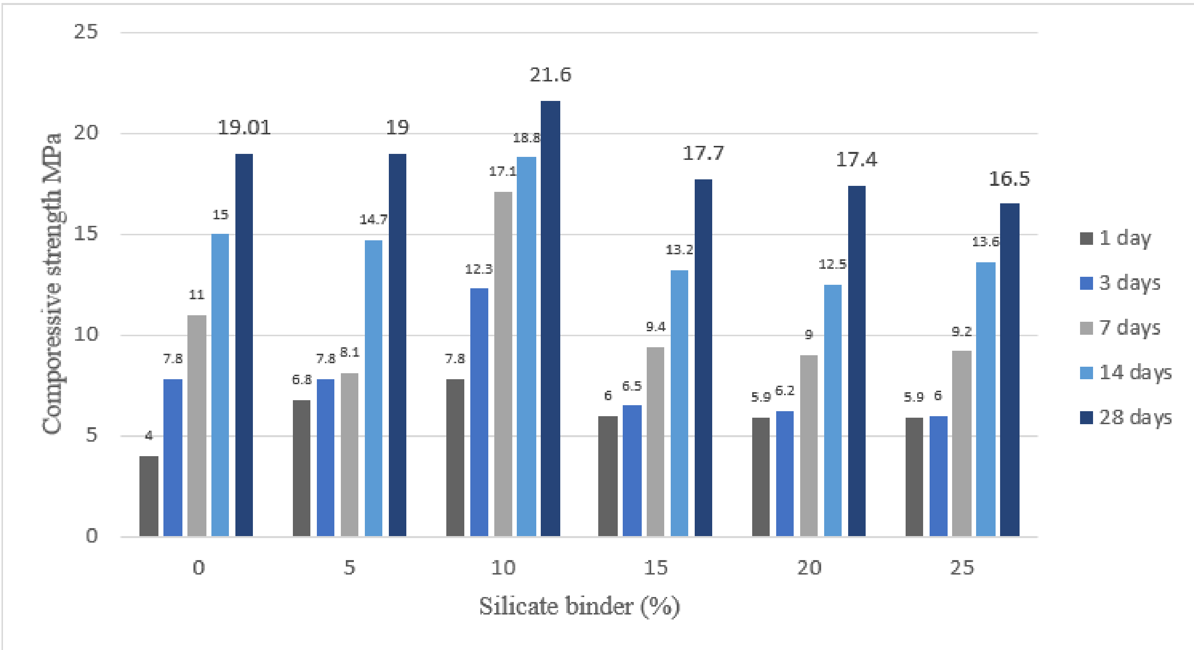

FIGURE 1. **Histogram Representation of Compressive strength**

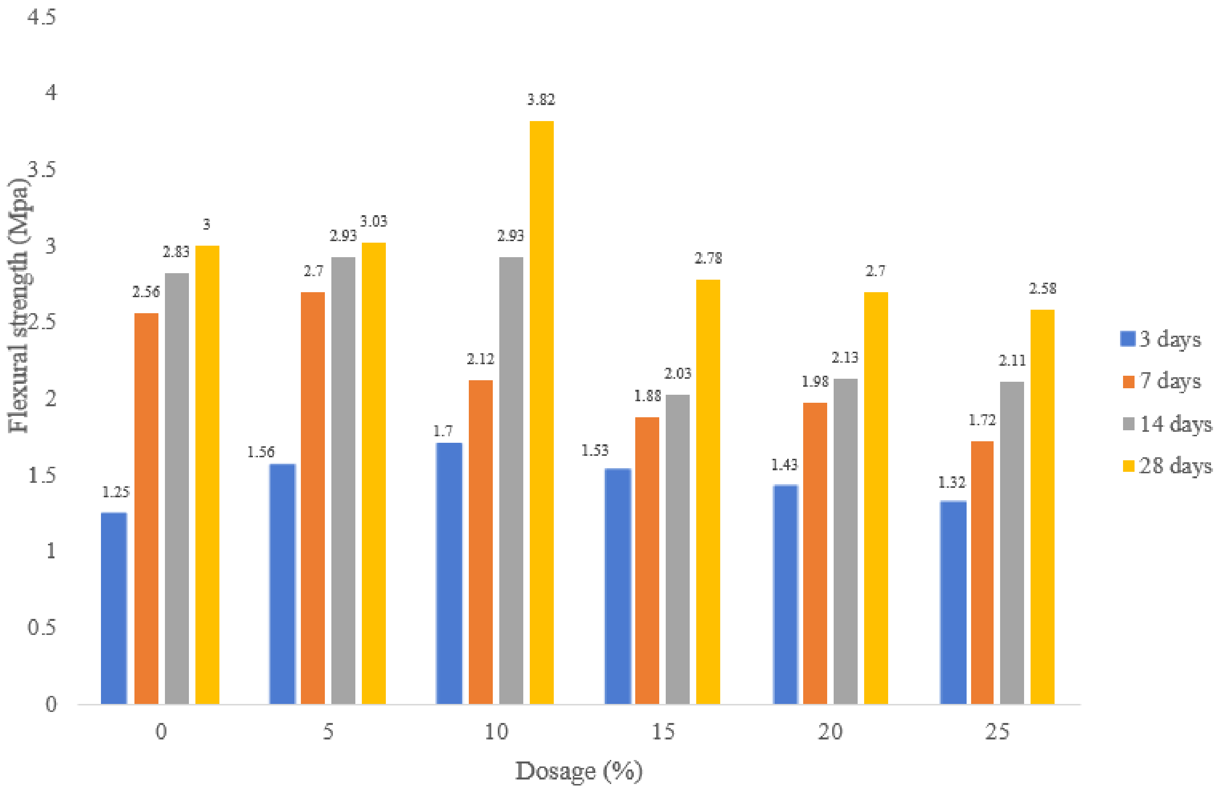

FIGURE 2. **Histogram Representation of Compressive strength**

carried out by varying the percentage of nano calcite in the blown bitumen emulsion mix of which 3% was found to be adequate proportion for the mix. Here, skid resistance, mean texture depth and water seepage was studied. The results of skid resistance shown in table 3 and the comparison results of mean texture depth are shown in table 4 and water seepage on table 5.

Mean Texture Depth (965).

TABLE 3. **Test Results of British Pendulum Tester on Wearing Coat**

Trail No:	Skid No:		Co-efficient of Friction		Skid Resistance	
	DRY	WET	DRY	WET	DRY	WET
1)	92	89	0.38	0.36	3.82	3.59
2)	94	88	0.38	0.36	3.81	3.58
3)	90	85	0.37	0.36	3.71	3.57

TABLE 4. **Mean Texture Depth on Wearing Coat Surface**

Trial no:	**DiameterO the patch(mm)**	**Mean**	**MTD**
1	501	504	0.45
2	515		
3	505		
4	495		

TABLE 5. **W ater Seepage**

Sl no.	Time taken by open graded sample(sec)	Time taken by wearing coat applied on sample(sec)
1)	19.0	35.8
2)	18.5	36
3)	19.5	35.2
4)	18.0	34
5)	18.4	34.2
Average	19	35

5. Conclusion

The results obtained through the study was the values of skid resistance obtained were within the range of 0.35-0.40 which is acceptable as per IRC specifications. Mean texture depth values showed medium texture can be obtained which offers good comfort to the riders. Wearing coat applied surface was able to be 5.2°C cooler and were able to prevent 53% more water seepage into the ground in comparison with the normal bituminous pavement surface. It was found from the studies that 10% Silicate binder dilution dosage air cured samples were able form a sustainable concrete mix and have shown higher strength results.

6. Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the pa-per was free of plagiarism.

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