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EFFECT OF NANO SILICA ON CONCRETE MIX DESIGN IN RIGID PAVEMENT

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Abstract— India is the second greatest highway framework on the earth. Owing of rising oil costs and an all the more firmly money related condition, cement is transforming into an all the more appealing decision compared to other road. Ministry of Road Transport and Highways in India saw that advance society can work effectively on concrete roads. The principle concentration now daily is toward the including of Nano silica sand in concrete for enhancing quality of concrete mix design to cope up ever increasing higher load carrying capacity vehicles on pavement. In my examination, at first M40 grade of concrete is outlined. In the mix, Nano silica sand has been taken into consideration by replacing Nano silica sand in measurements of 1%, 2%, 3%, 4% & 5% by the weight of cement to study the logical properties according to code by testing for workability, compressive and flexure strength. The rigid pavement thickness design utilizing IRC 58:2011 with various extent of Nano silica sand to find out cost effective rigid pavement design. The result shows that solid blend with Nano silica sand ends up being productive and can be suggested for pavement decision makers and contractors.

Keywords — Nano silica sand, compressive strength, concrete, economy, 40MPA strength.

I. INTRODUCTION

Concrete is the material of present as well as future. The wide use of it in structures, from buildings to factories, from bridges to airports, makes it one of the most investigated materials of the 21st century. So, to produce concrete with improved properties, the mechanism of cement hydration has to be studied properly and better substitutes to it have to be suggested. Different materials known as supplementary cementations materials or SCMs are added to concrete improve its properties. Some of these are fly ash, blast furnace slag, rice husk, silica fumes and even bacteria of the various technologies in use, Nano-technology looks to be a promising approach in improving the properties of concrete. Nanotechnology deals with measurement and characterization of the Nano and micro scale structure of cement based materials. Nano silica sand in concrete or mortar will increase the friction resistance, the density, reduces porosity, and improves the bond between cement matrix and aggregates with higher compressive and flexural strength. Also, it was found that the no behaves not only as a filler to improve the microstructure, but also as an activator to promote pozzolanic reactions and super-plasticizer plays an important role during mixing cement with Nano particles. These materials are very effective in changing the properties of concrete at the ultrafine level by the virtue of their very small size. Only a small percentage of cement can be replaced to achieve the desired results. These nano materials improve the strength and permeability of concrete. The use of Nano silica sand in concrete mix has shown results of increase in the compressive, tensile and flexural strength of concrete. It sets early and hence generally requires admixtures during mix design.

II. LITERATURE REVIEW

Bashar s. et. al (2018) In this study roller-compacted rubbercrete (RCR) was produced by partially replacing fine aggregate with CR. nano silica was used as an additive to cement to mitigate the loss of mechanical properties in RCR caused by incorporation of CR. The non-destructive tests, reboundhammer, ultrasonic pulse velocity are used to evaluate the performance of RCR. combine UPV-RN (SonReb) models for predicting the 28 days strength of RCR based on combining UPV and RN(rebound number) where developed using multi variable regression. It is concluded that the multi variable regression has better accuracy for predicting 28 days compressive strength of RCR.
The compressive strength, UPV, RN, and DMOE of percentage replacement of fine aggregate with CR above 10%.
The addition of NS up to 2% increases the compressive strength, UPV, RN, and DMOE of RCR.

Billamahende et. Al (2017) Due to rapid industrialization and urbanization in the country lot of infrastructure and urbanization in the country lot of infrastructure developments are taking place. This process as in turn lead questions to maintain to solve the problems generated by this growth the present investigation deals with partial replacement of waste plastic and waste rubber as particle replacement in concrete at an increment of 5% each time. In this study found that the concrete with waste plastic and waste rubber can be used for construction of rigid pavements, sewers, tennis courts and walker areas which leads to decrease in the overall thickness of the pavement. From the compressive strength results, it

can be observed that increase in compressive strength of concrete is observed on addition of a certain minimum quality of NS. The increase in strength is maximum for NS 1% b.w.c and least for NS 0.3% b.w.c. on addition of NS there is a substantial increase in the early Age strength of concrete compared to 28days increase in strength. The UPV test results show that the quality of concrete get slightly affected on addition of NS. But overall quality of concrete is preserved. The NS added to the mix filled up the pores in between the C-S-H gel, hence making the microstructuremore compact and uniform.

Bashar S. (2017) In this study Engeeredcementitious composite (ECC) has gralnedatlention among researchers due to its superior tensile properties to improve its modulus elasticity, due to absence of coarse aggregate,nano-silica (NS) has been added to ECC mixture.by using nondestructive tests such as rebound hammer (RH) and ultrasonic pulse velocity (VPV) to predict the compressive strength of NS-ECC is worthwhile. It is found Response surface methodology (RSM) has been performed to develop models for predicting the compressive strength of NS-ECC utilizing results from RH and UPV. This models can be used for predict the compressive or/and ultra-pulse velocity.
To archive a higher compressive strength of engineeredcementitious composite, the optimum amount of NS is 2%.

III. LABORATORY TESTS AND RESULTS

1. Tests on Aggregate

Aggregate used in the concrete is collected from IRSDC working site Gandhinagar, Gujarat. My concrete mix design is for M40 grade. Initially the physical properties of aggregates need to be carried out as per procedure laid down in IS code. The test to be performed is enlisted as follows:
1. Specific gravity and water absorption test IS: 2386 (Part 3) - 1963
2. Aggregate impact value test IS: 2386 (Part 4) – 1963
3. Determination of flakiness and elongation index IS: 2386 (Part 1) - 1963
4. Los Angeles abrasion value test IS: 2386 (Part 4) - 1963
5. Aggregate crushing value test IS: 2386 (Part 4) – 1963

2. Tests on Fine Aggregate

Table 1: Specific Gravity and Water Absorption Test IS: 2386 (Part 3)-1963

Sr. No.	Description		Trial – 1	Trial – 2
1	Weight of empty Pycnometer	W (gm)	662	668
2	Weight of SSD Sample	W1 (gm)	670	505
3	Weight of Pycnometer + sample + water	W2 (gm)	1960	1870
4	Weight of Pycnometer + water	W3 (gm)	1555	1562
5	Weight of Oven dry sample	W4 (gm)	652	498
6	Bulk Specific Gravity	= W4/[W1-(W2-W3)]	2.46	2.53
7	Apparent Specific Gravity	= W4/[W4-(W2-W3)]	2.64	2.66
8	Water Absorption (%)	= 100 x (W1-W4)/W4	2.76	1.40
9	Average Bulk Specific Gravity		2.5	
10	Average Apparent Specific Gravity		2.65	
11	Average Water Absorption %		2.08	

3. Tests on Cement

1. Field test

2. Laboratory test

Specific gravity of cement IS: 4031 (Part 11) - 1988
Normal consistency test IS: 4031 (Part 4) - 1988
Initial and final setting time of cement IS: 4031 (Part 5) - 1988
Fineness test IS: 4031 (Part 1) - 1988

Soundness test IS: 4031 (Part 3) – 1988
Compressive strength test

4. CONCRETE MIX DESIGN FOR PAVEMENT

M40 concrete mix design according to IS: 10262 – 2009 is carried out.

Mix proportion for trial.
Cement = 394.32kg/m3
Silica powder = 19.72kg/m3
Silica sand = 19.72kg/m3
Water = 157.73kg/m3
Fine aggregate = 832.83kg/m3
Silica powder = 39.55kg/m3
Silica sand = 42.12kg/m3
Coarse aggregate = 1059.96kg/m3
Chemical admixture = 3.94kg ≈ 4kg
Water cement ratio = 0.4

Table 2: Cement replacement by silica sand

Percentage	Mass of cement(kg/m3)	Mass of silica Sand(kg/m3)
0%	394.32	-
1%	390.38	3.94
2%	386.43	7.89
3%	382.49	11.83
4%	378.55	15.77
5%	374.60	19.72

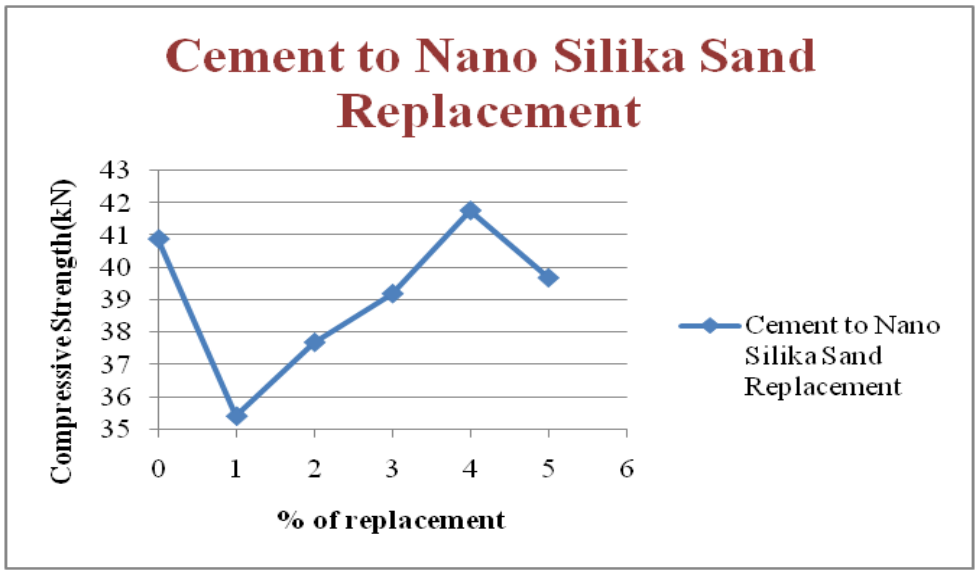

Figure 1: Cement to Nano Silica Sand Replacement

IV. CONCLUSIONS

In this study, fresh and hardened properties of nano silica sand modified pervious concrete were experimentally investigated. The following conclusions can be drawn: Effects of adding nano silica sand on the fresh properties of the cementitious paste of pervious concrete is marginal and can be fully offset using a small dosage of super plasticizer. The Maximum compressive strength obtain by 4% replacement of nano silica sand to cement and minimum compressive strength at 1% of replacement nano silica sand to cement.

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