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EVALUATIONS GGBS, METAKAOLIN AND WASTE MEDICINE WRAPPERS FOR SUSTAINABLE CONSTRUCTION

Sandeep Singh[*1], Gurpreet Singh[2], Rajat Verma [3]

[*1,2]*Assiatnt Professor, Department of Civil Engineering, Chandigarh University, Gharuan, Mohali*
[3]*Research Scholar, Department of Civil Engineering, Chandigarh University, Gharuan, Mohali*
drsandeep1786@gmail.com

Abstract

The investigation attempts to incorporate GGBS and Metakaolin as Fractional Substitution of cement and Waste Medicine Wrappers as fractional substitution of fine aggregates. In this study, the flexural, compressive, split tensile, Rebound hammer and ultrasonic pulse velocity test for pavement quality concrete mixtures for different percentage of GGBS and Metakaolin as replacement of cement and Waste Medicine Wrappers as replacement of fine aggregates are reported.

Keywords: GGBS, Metakaolin, Waste Medicine wrappers, Pavement, Strength

1. Introduction

Over the years, road structures have been affected more rapidly due to increase in traffic volume, so the scope of our study will be to use GGBS, Metakaoiln and Waste Medicine Wrappers in concrete. GGBS and Metakaolin have pozzolanic properties, On the other hand Medicine wrappers if untreated leads to waste material which causes adverse effect to our environment. So our aim is mainly focused on using these materials in concrete. After experimental work and analysis of the results we will use the values obtained to design the slab thickness considering cumulative fatigue life using IRC 58-2002 [1-2].

[3] studied the effect of fly ash and aluminum powder on strength properties of concrete. They replaced fly ash with cement at 5%,10% and 15% whereas aluminum powder was added at 0%,0.5% and1%.They concluded that that addition of fly ash and aluminum powder increases the strength properties of concrete [4] studied the evaluation strength characteristics of pavement quality mixes using GGBS and Manufactured Sand. They partially replace GGBS with cement and Manufactured Sand with Fine aggregates in different mixes. GGBS was replaced with cement at (10,20&30)%without any addition of Manufactured Sand. On the other hand Manufactured sand was partially replaced with fine aggregates at (20,40,60,80&100)%.They concluded that GGBS was found to have 20-30% higher strength value,12-14% higher compressive value,5-8% higher flexural value as compared to conventional concrete values. On the other hand Manufactured Sand have 14-16% higher compressive value, 12-14% higher flexural value as compared to conventional concrete. [5-8] studied the behavior of Pavement Quality Concrete containing construction, industrial and agricultural waste. They casted specimen with and without recycled concrete aggregates, Followed by 3 different mineral admixtures viz. Flyash, Rice Husk ash\&Baggage ash. They performed various mechanical and durability test. They concluded that fly ash admixture mix showed a gain of about 15%& 24% for concrete and flexural strength parameters while Rice Husk ash and Baggase ash mixes to be 12 % & 25% ,13% & 20% respectively when

compared to recycled aggregates concrete mix without mineral admixtures. [9-10] studied on concrete made by biomedical waste.They replaced biomedical waste ash by cement at replacement of 10%,15% and 20%.They observed that Compressive strength of concrete made using biomedical waste ash is more than that of conventional concrete upto 10% replacement level

2. Research Gap

The use of plastic waste which matches the size of fine aggregates was used for partial substitution up to 10% and Use of Waste PVC pipes on replacement with coarse aggregates at 15%,20% and 25% increases the strength properties of concrete.The use of Waste Medicine Wrappers as partial replacement of fine aggregates have not been focused much. We are replacing Waste medicine wrappers up to 15% and would investigate various mechanical properties.

On the other hand GGBS and Metakaolin are cementitious material which could be used as cement replacement. So we would be making different Pavement quality concrete mix using GGBS, Metakaolin and Waste Medicine Wrappers and study out the strength characteristics of Pavement Quality Concrete

3. Objective of the Study

1. To investigate the concrete strength with fractional substitution of GGBS and Metakaolin with cement and Waste Medicine wrappers with fine aggregates and compare it with conventional concrete by conducting test such as: Compressive test, Flexural test, Split Tensile test, USPV test and Rebound hammer test
2. To use of waste by products from the industries.
3. To reduce the problem of waste materials by using them in concrete.

4. Results and Discussion

Table 1: Compressive strength values

Mix	Compressive Strength in N/mm^2	
	7 days	28 days
CM	31.8	43.2
M1	32.6	44.6
M2	35.7	48.6
M3	34.96	46.97

Fig 2 Flexural Strength Values

Mix	Flexural Strength in N/mm^2	
	7 days	28 days
CM	6.5	8.2
M1	6.9	8.75
M2	7.72	9.7
M3	7.24	9.2

Table 3 Split Tensile Values

Mix	Split Tensile Strength in N/mm^2	
	7days	28days
CM	2.06	3.28
M1	2.35	3.54
M2	2.96	4.07
M3	2.64	4.04

Table 4 USPV Values

Mix	Ultra Sonic pulse velocity in km/s
	28 days
CM	4.16
M1	4.35
M2	5.16
M3	4.37

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Table 5 Rebound Number Values

Mix	Average Rebound Number
	28 days
CM	43.2
M1	44.6
M2	48.6
M3	46.97

Table 6:Design of Slab thickness for CM

Flexure Strength = 82kg/cm^2 Slab thickness = 20 cm						
Axle l tonnes	A.L. x 1.2	Stress, kg/cm^2	Stress Ratio	Expected Repetitions	Allowable Repetitions	Fatigue value
Single Axle						
20	24	40	0.48	71127	2400000	0.02
18	21.6	38	0.46	177820	143335000	0.01
16	19.2	32	0.39	569023	∞	0
14	16.8	28	0.34	1280303	∞	0
Tandem axle						
36	43.2	26	0.31	35564	∞	0
32	38.4	24	0.29	35564	∞	0
28	33.6	22	0.26	71128	∞	0
						0.03

Table 7: Design of Slab thickness for M1

Flexure Strength = 87.5kg/cm2 Slab thickness = 19 cm						
Axle load (AL),tonnes	**A.L. x 1.2**	**Stress, kg/cm^2**	**Stress Ratio**	**Expected Repetitions**	**Allowable Repetitions**	**Fatigue value**
Single Axle						
20	24	41	0.46	71127	14335000	0.004
18	21.6	40	0.45	177820	62790000	0.002
16	19.2	34	0.38	569023	∞	0.00
14	16.8	30	0.34	1280303	∞	0.00
Tandem axle						
36	43.2	26	0.29	35564	∞	0
32	38.4	24	0.27	35564	∞	0
28	33.6	22	0.25	71128	∞	0
						0.006

Table 8: Design of Slab thickness for M2

Flexure Strength = 97kg/cm^2 Slab thickness = 17 cm						
Axle load (AL), tonnes	**A.L. x 1.2**	**Stress, kg/cm^2**	**Stress Ratio**	**Expected Repetitions**	**Allowable Repetitions**	**Fatigue value**
Single Axle						
20	24	47	0.48	71127	2400000	0.02
18	21.6	44	0.45	177820	62790000	0.02
16	19.2	40	0.41	569023	∞	0.00
14	16.8	34	0.35	1280303	∞	0.00
Tandem axle						
36	43.2	34	0.35	35564	∞	0
32	38.4	32	0.32	35564	∞	0
28	33.6	28	0.28	71128	∞	0
						0.04

Table 9: Design of Slab thickness for M3

Flexure Strength = 92kg/cm2 Slab thickness = 18 cm						
Axle load (AL),tonne	**A.L. x 1.2**	**Stress, kg/cm2**	**Stress Ratio**	**Expected Repetitions**	**Allowable Repetitions**	**Fatigue value**

s						
Single Axle						
20	24	44	0.47	71127	5200000	0.013
18	21.6	42	0.45	177820	62790000	0.002
16	19.2	37	0.40	569023	∞	0.00
14	16.8	33	0.35	1280303	∞	0.00
Tandem axle						
36	43.2	31	0.33	35564	∞	0
32	38.4	28	0.30	35564	∞	0
28	33.6	26	0.28	71128	∞	0
						0.015

5. Conclusion and Recommendations

1. Concrete mix with 20% GGBS and 15% Metakaolin as replacement of cement and 10% Waste Medicine Wrappers as replacement with fine aggregates is the optimum level as it has been observed to show a significant increase in compressive strength at 28 days when compared with nominal mix...
2. The split tensile strength also tends to increase with increase percentages of Waste Medicine up to 10% mix but slightly decrease after 10 % replacement but is more than control mix.
3. On increasing the percentage replacement of Fine aggregates with waste medicine wrappers beyond 10%, there is a reduction in the tensile strength value. So 10% Waste Medicine Wrappers replacement is optimum for split tensile strength.
4. Similarly for nondestructive test such as USPV and Rebound Hammer Test mix M2 showed the maximum optimum values.

5.1.Reasons of Increase in the Strength

1. The strength properties of concrete specimen containing plastic fails due to decrease in bond strength between surface of plastic aggregates and cement paste in addition due to smooth surface of plastic aggregates and improper grading of plastic aggregates.
2. Reduction in strength occur when plastic is added to a concrete mix is generally due to either debonding of plastic from the cement matrix or failure of plastic itself.Failure mode is dependent on shape, type and texture of plastic.
3. From the past study by Thorneycroft et al. (2018) displayed the increase in mechanical properties of concrete by using plastic aggregates by replacement with fine aggregates. They replace fine aggregates with plastic waste matching the size of fine aggregates .Due to fineness of plastic the bonding between plastic and cement matrix was increased which results in the increase of mechanical properties of concrete as compared to control mix.
4. The Waste Medicine wrappers used in our study have been matched with the size of fine aggregates been used which helps to reduce the ITZ region.
5. In addition the use of mineral admixtures helps to solidify the smooth surface of particles of Waste medicine wrappers which aims to increase the microhardness of ITZ and decrease the width of ITZ as the results strength value increases.

Reference

1. Singh, Gaurav, et al. "Study of granulated blast furnace slag as fine aggregates in concrete for sustainable infrastructure." *Procedia-Social and Behavioral Sciences* 195 (2015): 2272-2279.
2. ARASAN, GV, and GANAPATHY RAMASAMY. "Study On Strength Properties Of Concrete Using Ggbs And Steel Fiber As Partial Replacement Of Cement." *Journal of Industrial Pollution Control* (2017): 1255-1259.
3. Aciu, Claudiu, et al. "Recycling of plastic waste materials in the composition of ecological mortars." *Procedia Manufacturing* 22 (2018): 274-279.
4. Thorneycroft, James, et al. "Performance of structural concrete with recycled plastic waste as a partial replacement for sand." *Construction and Building Materials* 161 (2018): 63-69.
5. Hama, Sheelan M., and Nahla N. Hilal. "Fresh properties of self-compacting concrete with plastic waste as partial replacement of sand." *International Journal of Sustainable Built Environment* 6.2 (2017): 299-308.
6. Appiah, Johnson Kwabena, Victor Nana Berko-Boateng, and Trinity Ama Tagbor. "Use of waste plastic materials for road construction in Ghana." *Case studies in construction materials*6 (2017): 1-7.
7. Patel, Harshad G., and Sejal P. Dalal. "An experimental investigation on Physical and Mechanical properties of Concrete with the replacement of fine aggregate by Poly Vinyl Chloride and Glass waste." *Procedia engineering* 173 (2017): 1666-1671.
8. Manjunath, BT Ashwini. "Partial replacement of E-plastic Waste as Coarse-aggregate in Concrete." *Procedia Environmental Sciences* 35 (2016): 731-739.
9. Saikia, Nabajyoti, and Jorge de Brito. "Mechanical properties and abrasion behaviour of concrete containing shredded PET bottle waste as a partial substitution of natural aggregate." *Construction and building materials* 52 (2014): 236-244.
10. Duan, Ping, et al. "Enhancing microstructure and durability of concrete from ground granulated blast furnace slag and metakaolin as cement replacement materials." *Journal of Materials Research and Technology* 2.1 (2013): 52-59.