Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 3, Issue 7; April-June, 2016, pp. 645-647

http://www.krishisanskriti.org/Publication.html

Properties of Cement Mortar Containing Recycled Fine Aggregate

Janmejaya Barik[1], Rakesh Kumar Patra[2] and Bibhuti Bhusan Mukharjee[3]

[1,2,3]Veer Surendra Sai University of Technology, Burla Sambalpur Odisha 768018
E-mail: [1]rkp9306@gmail.com, [2]rkp306@gmail.com, [3]bibhuti.2222@gmail.com

Abstract—*The effect of recycled fine aggregate (RFA) on the properties of mortar is investigated in this present research work. Mortar specimens are prepared with three different water/cement ratios (0.4, 0.45, and 0.5) and three different percentages of recycled aggregate (10%, 20%, and 30%) as replacement of natural fine aggregate. Compressive strength of mortar specimens are tested after 3, 7 and 28 days of curing. In addition to this water absorption of mortar specimens are carried out. The study reveals that the strength of mortar specimen decreases with the increasing percentage of recycled fine aggregate. However, water absorption of specimens decreases with the increase in RFA (%).*

1. INTRODUCTION:

With the growth of the population and the ever increasing housing and infrastructural demands, the consumption of natural resources and energy is also increasing, leading to damage of natural landscapes and strain in some ecosystems. Therefore, concerns regarding sustainability have been regarded much more seriously in the last decades. The construction sector is one of the most influential in the production of waste and consumption of natural resources. Therefore, recycling of the waste concrete generated from construction and demolition waste (CDW) is found to beneficial in terms of environmental protection and mitigation of shortage of aggregates. The use of old construction materials in new constructions is not a new technique. Therefore effect of RFA on the properties of mortar is carried out in this present investigation.

Addition of RFA decreased the performance of concrete irrespective of the water absorption properties (Buyle and Hadijeva 2002). Moreover, the addition of RFA in concrete decreased both the splitting tensile strength and modulus of elasticity of concrete. There was not any significant change in the compressive strength upto 30% replacement ratio (Evangelista and Brito 2007). In addition to above addition of RFA upto 50% replacement level showed improvement in the sulphate resistance of mortar specimens (Lee et al. 2008). Similar conclusions were reported by Chi-sun and Shi-kong (2010) i.e. the mechanical properties of mortar prepared with different percentages of RFA decreased with the increase in the RFA%. Addition of 100% RFA was not feasible for construction work. The strength properties of RFA content concrete was similar to that of normal concrete upto 30% addition of RFA (Miren et al. 2013).

Use of CDW wastes is useful for the society as well as for the environment. Hence a detailed experimental investigation is carried out to check the effect of RFA on the strength as well as durability properties of mortar in the present study.

2. EXPERIMENTAL INVESTIGATION:

RFA used in this present research work was collected from the demolished buildings in Burla Municipal Corporation. River sand was used as the natural fine aggregate. Ordinary Portland Cement (OPC) 43 grade conforming to the requirements of BIS (IS: 8112-1989) was used in the entire experimental study. The consistency and specific gravity of OPC was found to be 31% and 2.97. Three different types of water/cement ratios were taken 0.4, 0.45, and 0.5 with 3 different percentage of RFA 10%, 20% and 30%. The cubes were tested in 2000 KN capacity compressive strength machine and the rate of loading is maintained throughout the program as per BIS specification (IS: 516, 1959). The particle size distribution was carried out in accordance with BIS (IS: 2386 (Part 1) - 1963). The grading of aggregate was determined by the cumulative percentage passing by weight through the standard sieves conforming to BIS (IS: 460 (Part 2) - 1985). The test results of natural fine aggregates, recycled fine aggregate showed that it belonged to zone-II. The specific gravity and water absorption of natural aggregates and RFA was found to be 2.6 and 2.3%, and 2.43 and 7.5% respectively.

3. RESULT AND DISCUSSION:

The compressive strength (CS) of mortar specimens are tested after 3, 7 and 28 days of curing period and the results are presented in the fig- 1, 2 and 3. Also water absorption (WA) test of mortar is carried out and the result is given in fig-4.

Fig- 1 represents the variation of 3 days CS with of mortar specimens with respect to W/C ratio. It can be seen that the 3 days CS of control mortar at w/c ratio 0.4 is 23.23 MPa, which reduces to 21.7 MPa when 10% of natural is replaced by

recycled fine aggregates. Similarly, CS of mortar containing 20% and 30% RFA are found to be 20.19MPa and 18.8 MPa. For w/c ratio 0.45, the 3 days CS of control mortar is 20.79 MPa which reduced to 19.98, 17.69 and 15.8 MPa with 10%, 20% and 30% replacement respectively. Moreover, for the w/c ratio 0.50, the control mortar strength is 16.59 MPa. This is reduced to 15.94, 14.8, 12.25 MPa with 10%, 20% and 30% replacements. This reduction of CS with increasing percentage of fine aggregates is due to inferior quality of recycle fine aggregates as compared to natural sand. Moreover, this reduction of compressive strength could be attributed to the poor bonding between the cement paste and aggregates.

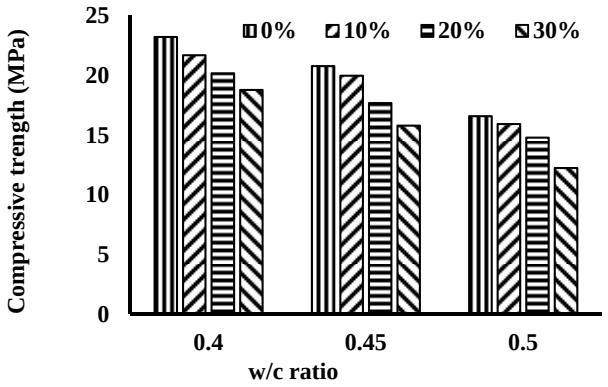

Fig. 1 Variation of 3 days compressive strength

Fig- 2 represents the variation of 7 days CS with of mortar specimens with respect to W/C ratio. It can be seen that the 28 days CS of control mortar at w/c ratio 0.4 is 33.43 MPa, which reduces to 31.6 MPa when 10% of natural is replaced by recycled fine aggregates. Similarly, CS of mortar containing 20% and 30% RFA are found to be 28.7 MPa and 26.41 MPa. For w/c ratio 0.45, the 7 days CS of control mortar is 27.62 MPa which reduced to 26.91, 23.84 and 21.95 MPa with 10%, 20% and 30% replacement respectively. Moreover, for the w/c ratio 0.50, the control mortar strength is 23.9 MPa. This is reduced to 23.07, 22.56, AND 20.5 MPa with 10%, 20% and 30% replacements. This reduction of CS with increasing percentage of fine aggregates is due to inferior quality of recycle fine aggregates as compared to natural sand. Moreover, this reduction of compressive strength could be attributed to the poor bonding between the cement paste and aggregates.

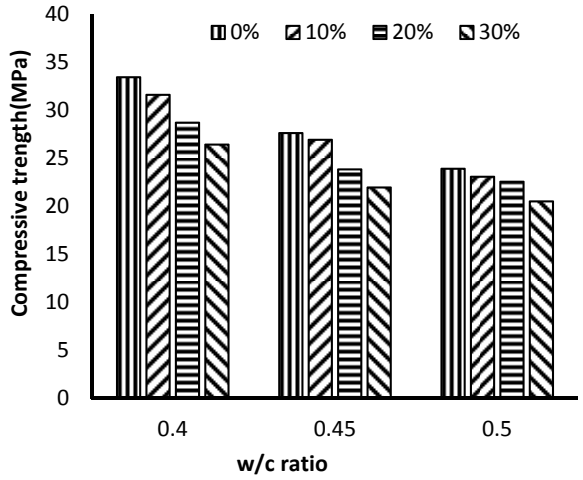

Fig 2 Variation of 7 days compressive strength

The variation of 28 days CS with of mortar specimens with respect to W/C ratio is represented in Figure- 3. It can be seen that the 28 days CS of control mortar at w/c ratio 0.4 is 49.12 MPa, which reduces to 46.78 MPa when 10% of natural is replaced by recycled fine aggregates. Similarly, CS of mortar containing 20% and 30% RFA are found to be 44.1 MPa and 40.66 MPa. For w/c ratio 0.45, the 28 days CS of control mortar is 43.6 MPa which reduced to 41.54, 40.74 and 38.67 MPa with 10%, 20% and 30% replacement respectively. Moreover, for the w/c ratio 0.50, the control mortar strength is 39.2 MPa. This is reduced to 35.35, 32.35, and 29.41 MPa with 10%, 20% and 30% replacements. This reduction of CS with increasing percentage of fine aggregates is due to inferior quality of recycle fine aggregates as compared to natural sand. Moreover, this reduction of compressive strength could be attributed to the poor bonding between the cement paste and aggregates.

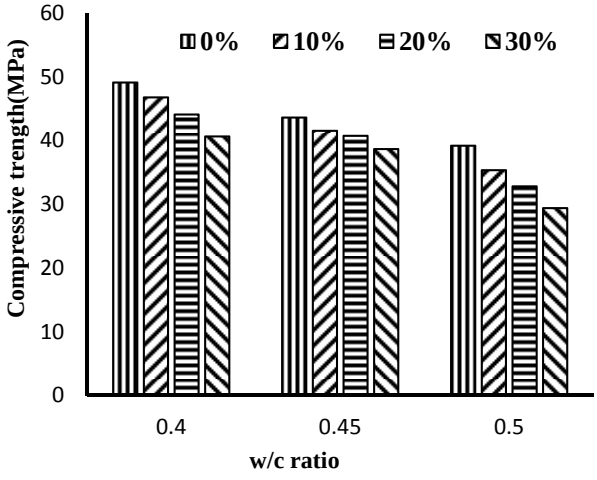

Fig- 3 Variation of 28 days compressive strength

Fig- 4 represents the percentage of water absorption with respect to different W/C ratio for different RFA replacement percentage. At 0% replacement i.e. in the control mortar the water absorption is 4.73%, 6.49%, & 7.53% for w/c ratio of 0.40, 0.45, & 0.50 respectively. Again for 10% replacement the water absorption is 6.9%, 7.4%, & 9.46% respectively. Similarly for 20% replacement, for w/c 0.40, 0.45 & 0.50 the water absorption is 7.49%, 8.05%, & 10.84% respectively. Similarly for 30% replacement, for w/c 0.40, 0.45 & 0.50 the water absorption is 8.64%, 9.04%, & 11.35% respectively. By comparing these values we can see that with increase in w/c ratio water absorption increases as the porosity increases. Also we can find that the water absorption is directly proportional to the replacement percentage as the recycled aggregates absorb more water.

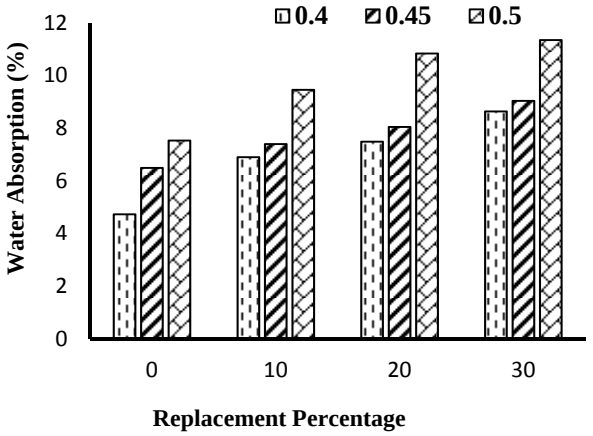

Fig- 4 Variation of water absorption of mortar specimens.

Fig- 5 represents the relation between relation between 28-day water absorption and 28-day compressive strength. From this, it can be seen that water absorption is inversely proportional to the compressive strength. We can find a relation between them as

$$\text{28-day WA} = -0.3119(\text{28-day CS}) + 20.688$$

The R^2 value for this equation is 0.9076. As this value is above 0.90, the equation holds good.

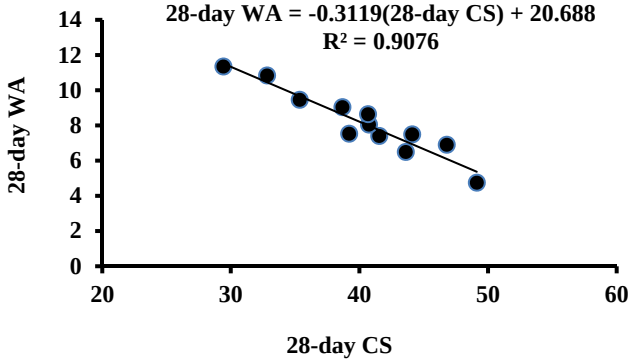

Fig-5 Relation between water absorption and 28 days compressive strength

4. CONCLUSION:

In the present study the effect of different percentage of RFA on the properties of mortar specimens are carried out and following conclusions are drawn.

- Gradation of RFA is similar to that of natural sand whereas the specific gravity of RFA is less than the natural fine aggregate.
- Compressive strength of specimens decreases with the increasing percentage of RFA. In addition to this with the increase of water/cement ratio compressive strength decreases. Therefore an optimum value of 0.45 water/cement ratio can be used.
- Water absorption also increases with the increase in RFA% and water/cement ratio. Specimen having 0.5 water/cement ratio have highest values of water absorption.

REFERENCE:

[1] Etxeberria, M., Ainchil, J., Pérez, M. E., & González, A. Use of recycled fine aggregates for Control Low Strength Materials (CLSMs) production. Construction and Building Materials, 44, (2013) Pages: 142-148.

[2] Kou, S. C. Properties of cementitious rendering mortar prepared with recycled fine aggregates. Journal of Wuhan University of Technology-Mater. Sci. Ed., 25(6), (2010) Pages: 1053-1056.

[3] Evangelista, L., & De Brito, J. Mechanical behaviour of concrete made with fine recycled concrete aggregates. Cement and Concrete Composites, 29(5), (2007) Pages: 397-401.

[4] Buyle-Bodin, F., & Hadjieva-Zaharieva, R. Influence of industrially produced recycled aggregates on flow properties of concrete. Materials and Structures, 35(8), (2002) Pages: 504-509.

[5] Cuenca-Moyano, G. M., Martín-Morales, M., Valverde-Palacios, I., Valverde-Espinosa, I., & Zamorano, M. Influence of pre-soaked recycled fine aggregate on the properties of masonry mortar. Construction and Building Materials, (2014). Pages: 70, 71-79.

[6] Lee, S. T. Influence of recycled fine aggregates on the resistance of mortars to magnesium sulfate attack. Waste management, 29(8), (2009). Pages: 2385-2391.

[7] Leite, M. B., do Filho, J. G. L. F., & Lima, P. R. Workability study of concretes made with recycled mortar aggregate. Materials and structures, 46(10), (2013). Pages: 1765-1778.

[8] Martínez, I., Etxeberria, M., Pavón, E., & Díaz, N. A comparative analysis of the properties of recycled and natural aggregate in masonry mortars. Construction and Building Materials, 49, (2013). Pages: 384-392.

[9] Miranda, L. F., Constantino, C. S., Monich, C. R., & Neto, A. A. D. M. Use of recycled sand produced at construction sites in bedding mortars. Journal of Materials in Civil Engineering (2012).

[10] Tovar-Rodríguez, G., Barra, M., Pialarissi, S., Aponte, D., & Vázquez, E. Expansion of mortars with gypsum contaminated fine recycled aggregates. Construction and Building Materials, 38, (2013). Pages: 1211-1220.

[11] Zhao, Z., Remond, S., Damidot, D., & Xu, W. Influence of fine recycled concrete aggregates on the properties of mortars. Construction and Building Materials, 81, (2015). Pages: 179-186