Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 4, Issue 5; April-June, 2017, pp. 356-359
© Krishi Sanskriti Publications
http://www.krishisanskriti.org/Publication.html

Effect of Rice Husk Ash on Compressive Strength of Recycled Aggregate Concrete

Rupali Subhasmita Padhi[1] and Bibhuti Bhusan Mukharjee[2]

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

Abstract—*The influence of rice husk ash (RHA) as replacement of cement on compressive strength of recycled aggregate concrete is investigated in this study. For this, concrete mixes (both natural and 100% recycled coarse aggregate) containing 0%, 5%, 10%, 15%, 20%, 25% ,30% and 35% rice husk ash has been prepared in accordance to the BIS standard procedures. The water binder ratio of the concrete is maintained 0.45 and compressive strength after 7, 28, and 90 days of curing has been determined and compared with the result of reference concrete (without recycled coarse aggregates and RHA). The results of the experimental investigation depicts about reduction in compressive strength has been detected with the incorporation of recycled coarse aggregates and further reduced with the use of rice husk ash as replacement of cement. However, the development of strength in RHA mixes in later stages is better as compared to early days.*

1. INTRODUCTION

Several problems associated with construction industry such as shortage of natural aggregates, lack of space for dumping of waste generated from construction and demolition site could be solved with the Utilization of aggregates retrieved from construction and demolition waste in concrete. The coarse fractions of aggregates prepared by crushing waste concrete are known as recycled coarse aggregate (RCA). The properties of recycled coarse aggregates are inferior to the natural coarse aggregates due to Presence old adhered mortar in it (Kou et al. (2012) [5]. The workability of concrete containing RCA decreased than NAC due to the high water absorbing capacity of recycled aggregates. It can be overcome by incorporation of mineral and chemical admixture, by adding extra water corresponding to the absorption of aggregates and presoaking the aggregates (Tavakoli et al. (1996) [10]. Presence old adhered mortar in it (Kou et al. (2012) [5]. The workability of concrete containing RCA decreased than NAC due to the high water absorbing capacity of recycled aggregates. It can be overcome by incorporation of mineral and chemical admixture, by adding extra water corresponding to the absorption of aggregates and presoaking the aggregates (Tavakoli et al. (1996) [10]. The RCA should be pre-soaked for 20 minutes in half of the calculated mixing water to control the slump loss. The compressive strength of recycled aggregates found to remain unchanged up to replacement level 30% beyond this level strength started decreasing (Xiao et al. (2012).[11].At 100% replacement of RCA the reduction in compressive strength of RAC is up to 30% of NAC (Tam et al. (2005). The reduction in Split tensile strength is up to 24% at 100% replacement level of RCA (Rao et al. (2011) [8]. Both flexural and split tensile strength reduced up to 10% at different replacement level of RCA (Hansen et al. (1992) [4]. Use of rice husk as replacement of cement in making concrete has been increased to minimize cement consumption and protection of environment by reducing CO_2 emissions. It was found that desired slump could be maintained by increasing amount of water and adding super plasticizer with the increasing percentage of RHA .The slump of concrete decreased owing to high surface area of RHA (Cordeiro et al. (2009).[3]. The Compressive strength of concrete containing 10% RHA decreased up to 28 days after that the concrete showed the same or higher strength than the control mix (Anwar et al. (2000).[1]. During early ages the strength of concrete with RHA attained very low as compared to normal concrete. (Madandoust et al. (2011).[6].The reason behind achieving high strength after later stage by using RHA in concrete could be attributed to the very high activity of RHA due to presence of high silica content. That silica in RHA reacted with Ca ion and OH ion to produce C- S- H gel with the formation of more

C- S – H gel, less portlandite, smaller pore size and higher strength that's why RHA blended concrete was formed as compared to normal concrete. In this case optimum replacement of RHA value is 30%.

The present study tries to investigate the effect of incorporation of recycled coarse aggregate and rice husk ash on workability and compressive strength of concrete. Concrete mixes containing natural aggregates and 100% recycled coarse aggregates along with varying percentage of rice husk ash (0%, 5%, 10%, 15%, 20%, 25%, 30% and 35%) has been designed. The workability of aforementioned mixes and compressive strength after 7, 28, and 90 days has been determined to access the influence of RHA and RAC.

2. EXPERIMENTAL PROGRAMME

In this experimental programme the recycled coarse aggregate which was used was collected from railway ballast sleepers and for both NCA (Normal coarse aggregate) and RCA (Recycled coarse aggregate). The nominal size of the aggregate was taken as 20mm and the river sand which was used as NFA (Natural fine aggregate). The type of cement was ordinary Portland cement (OPC) of grade 43. In this present research work the RHA (Rice husk ash) was collected from Radha Krishna mill of Hirakud. The detailed properties of aggregates and cement are shown in Table1 and 2.

Table 1: Properties of aggregates

Property	NFA	NCA	RCA
Bulk density (compact) (kg/m^3)	1500	1450	1390
Bulk density (Loose) (kg/m^3)	1595	1676	1581
Specific gravity (SSD)(gm/cm3)	2.638	2.77	2.45
Water absorption (%)	0.5	0.33	3.28
Fineness modulus(mm)	2.34	6.67	6.48
LOS (%)	-	22.26	28.89
Impact value	-	17.3	19.81
Crushing value (%)	-	20.1	22.12

Table 2: Physical properties of Cement

Property		Result
Consistency		32
Initial setting time (min.)		39
Final setting time (min.)		385
Fineness (%)		96.7
Specific gravity (gm/cm^3)		3.13
Compressive strength (N/mm^2)	3 days	26.57
	7 days	35.87
	28 days	49.37

The Non ground rice husk ash is used in this study which is non crystalline and greyish black in color. The shape texture is irregular. It is odorless. The specific gravity of rice husk ash is 2.08.Loose and compacted bulk density of this RHA are 186 and 303 gm/cc respectively.

Table 3: Detailed Proportion for 1m^3 of concrete mixes

Mix Designation	RHA (%)	RCA (%)	Cement (kg)	RHA (kg)	NFA (kg)	NCA (kg)	RCA (kg)
NAC0	0	0	410	0	620	1200	0
RAC 0	0	100	410	0	620	0	1060
NAC 5	5	0	389.5	20.5	620	1200	0
RAC 5	5	100	389.5	20.5	620	0	1060
NAC 10	10	0	369	41	620	1200	0
RAC 10	10	100	369	41	620	0	1060
NAC 15	15	0	348.5	61.5	620	1200	0
RAC 15	15	100	348.5	61.5	620	0	1060
NAC 20	20	0	328	82	620	1200	0
RAC 20	20	100	328	82	620	0	1060
NAC 25	25	0	307.5	102.5	620	1200	0
RAC 25	25	100	307.5	102.5	620	0	1060
NAC 30	30	0	287	123	620	1200	0
RAC 30	30	100	287	123	620	0	1060
NAC 35	35	0	266.5	143.5	620	1200	0
RAC 35	35	100	266.5	143.5	620	0	1060

In this experimental research the replacement percentage of RCA was 0% and 100% of NCA and from 0%, 5%, 10%, 15%, 20%, 25%, 30% and 35% of cement RHA was replaced. The mixes of concrete were prepared by taking W/B ratio as 0.45. To control the slump loss the RCA are presoaked for 20 minutes in half of the calculated mixing water. The Cubes of 150 mm were prepared for evaluating the compressive strength of concrete in which the capacity of compressive strength machine was 2000kN.The loading rate of compressive strength testing machine was considered according to BIS (IS: 516 1959).The 150mm cubes were tested after 7, 28 and 90 days of curing. In table 3 detailed experimental mix designs were shown.

3. RESULT AND DISCUSSION

The variation of workability of natural and recycled aggregate concrete mixes with respect to RHA (%) is presented in Fig. 1. The slump of control mix without RHA and RCA is found to be 73 mm, which reduced to 71mm,64mm,59mm,48mm, 44mm and 40mm with the incorporation of 5%, 10%, 15%, 20%, 25%, 30%, and 35% of RHA respectively.

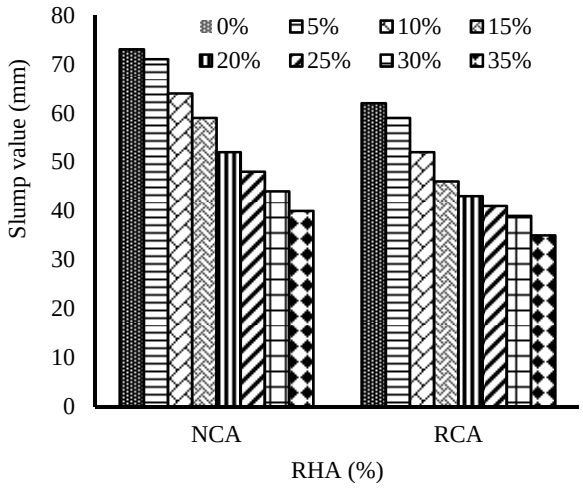

Fig. 1: Slump value of concrete mixes with different percentage of RHA

The reduction in workability could be due to the high water absorbing. The slump of concrete containing 100% RCA was 62mm which reduced to 59mm, 52mm,46mm,43mm,41mm,39mm and 35mm at 5%, 10%, 15%, 20%, 25%, 30% and 35% incorporation of RHA. By the

addition of RCA and RHA there is a decreasing trend for the workability of mixes however this reduction in slump is within the workable limits of concrete.(The RCA were presoaked for 20 minutes before casting.). It is observed that due to high water absorption value of RCA and RHA the decrease in slump value is more at 100% of RCA and 35% of RHA.

4. COMPRESSIVE STRENGTH

The compressive strength tested after curing period of 7, 28 and 90 days and presented in Fig. 2, 3 and 4. The compressive strength of concrete (both NAC & RAC) containing RHA for 150 mm cubes after 7 days of curing is presented in fig.2 It is found that the compressive strength of control concrete is found to be 29.8 MPa which is reduced to 27.5 MPa, 26 MPa, 25.3 MPa, 22.7 MPa, 19.1 MPa, 17.97 MPa, and14.02 MPa with the incorporation of 5%, 10%, 15%, 20%, 25%, 30% and 35% of RHA. It is observed the compressive strength of RAC is 23.9 MPa which is 19.79 % lower than the NAC.RAC containing RHA attains lower value such as 22.34 MPa, 21.2 MPa, 20.31 MPa, 17.63 MPa, 14.7MPa, 13.17 MPa and 10.05 MPa at 5%, 10%, 15%, 20%, 25%, 30% and 35% replacement of cement with RHA.

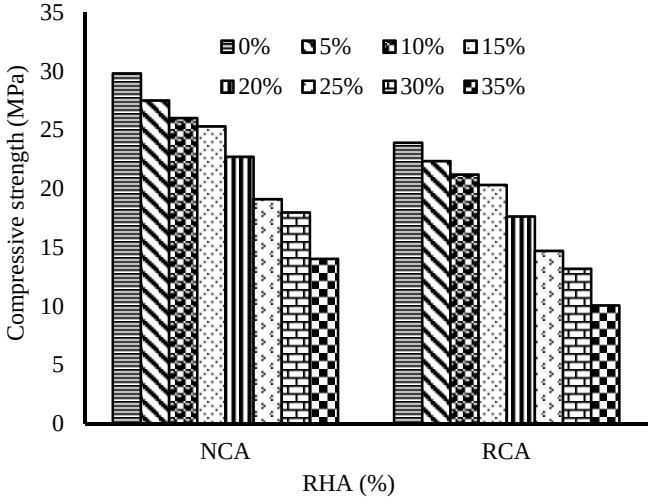

Fig. 2 Variation in 7 days compressive Strength

Fig.3 represents the compressive strength of concrete cubes after 28 days of curing. It is observed that after 28 days of curing the compressive strength of control mix is found as 41 MPa. The RHA when added as 5%, 10%, 15%, 20%, 25%, 30% and 35% to NAC the reduction in compressive strength are recorded as 39.5 MPa, 38.7 MPa,37.1 MPa,32.3 MPa,28.9 MPa, 25.6 MPa, and 21.2 MPa respectively which are 3.65%, 5.60%, 9.512%, 21.2%, 37.5% and 48.2% lower than the control concrete. There is also decreasing trend is noticed for the compressive strength of RAC incorporates RHA. At 100% RCA the Compressive strength is 34.44 MPa, which is reduced to 34 MPa,32.5 MPa, 31.17 MPa, 27.132 MPa, 24.276 MPa, 22.7 MPa and 17.9 MPa for 5%, 10%, 15%, 20%, 25%, 30% and 35% replacement of RHA. The reduction in compressive strength of concrete is attributed due to the enhancement of replacement percentage of RCA and RHA.

Fig.4 represents the compressive strength of concrete cubes at 90 days of curing. The compressive strength of control concrete (without RCA and RHA) is 44.1 MPa, The value of compressive strength 42.46 MPa, 41.8 MPa, 40.2 MPa, 35.41 MPa, 32 MPa, 28.72 MPa and 24.34 MPa by the addition of RHA at 5%, 10% and15%, 20%, 25%, 30% and 35% respectively the compressive strength of cubes with RHA are 3.71%, 5.21%, 8.84%, 19.70%, 27.43% 34.87% and 44.8% lower than the control concrete. Similarly the compressive strength of RAC at 100% is 39.25 MPa.

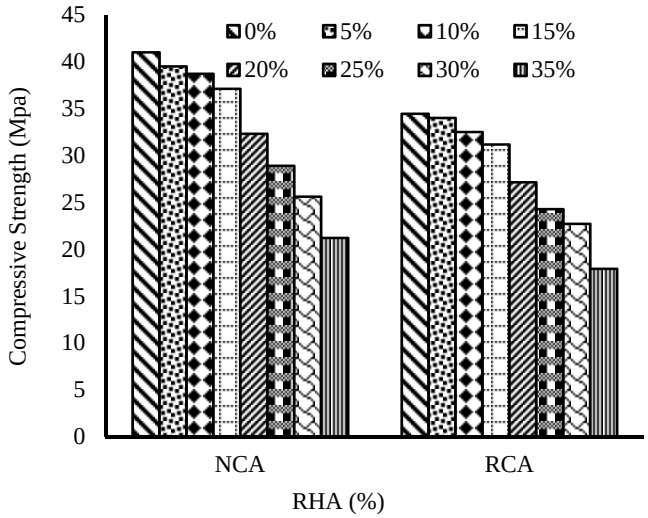

Fig. 3 Variation in 28 days Compressive strength

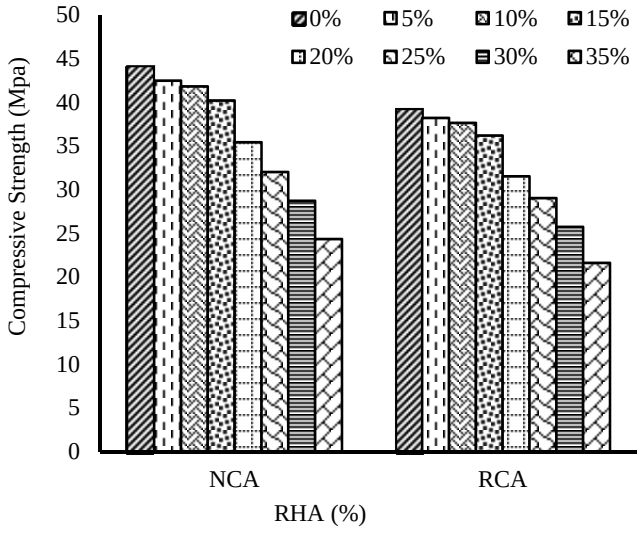

Fig. 4: Variation in 90 days Compressive strength

However at 5% to 35% of RHA that value reduced to 38.2MPa, 37.62MPa, 36.18MPa, 31.52MPa, 29.02 MPa, 25.73MPa and 21.615 MPa respectively. Due to less bonding and mechanical properties of RCA the compressive of RAC reduced in comparison to the NAC. Non-ground RHA was used in this study so the amount of C-H by the hydration process is insufficient to react with available silica as a result some silica left without chemical reaction and hence compressive strength reduced.

5. CONCLUSION

From this above research work, the effect of RCA and RHA on compressive strength of concrete is determined and conclusion from the above study are listed below.

- There workability of concrete mixes is influenced with the addition of RCA and RHA in concrete. This reduction workability decreases with increasing percentage of RCA and RHA.
- Compressive strength of concrete decreases by the incorporation of RCA because the void or space is increased by the addition of RCA. The Compressive strength of concrete further reduces with the enhancement of RHA level. However, concrete of desired target strength could be achieved with the use 0f 100% RCA and 10 to 15% RHA.
- The strength development from days to 90 days in concrete mixes continuing RCA and RHA is similar to control mix made without RCA and RHA.
- The concrete incorporating RHA and RCA can be beneficial for application in construction industry.

REFERENCES

[1] Anwar, M., Miyagawa, T., & Gaweesh, M. (2000). Using rice husk ash as a cement replacement material in concrete. Waste Management Series, 1, 671-684.

[2] Bureau of Indian Standards. (1959). Indian Standard methods of tests for strength concrete. IS: 516 (Reaffirmed in 1999), New Delhi.

[3] Cordeiro, G. C., Toledo Filho, R. D., & Fairbairn, E. D. M. R. (2009). Use of ultrafine rice husk ash with high-carbon content as pozzolan in high performance concrete. Materials and Structures, 42(7), 983-992

[4] Hansen TC, editor. Recycling of Demolished Concrete and Masonry. Oxfordshire, UK: Taylor and Francis; 1992.

[5] Kou, S. C., Poon, C. S., & Wan, H. W. Properties of concrete prepared with low-grade recycled aggregates. Construction and Building Materials, (2012). 36, 881-889.

[6] Madandoust, R., Ranjbar, M. M., Moghadam, H. A., & Mousavi, S. Y. (2011). Mechanical properties and durability assessment of rice husk ash concrete.Biosystems engineering, 110(2), 144-152.

[7] Qing-ge, F., Qing-yu, L., Qi-jun, Y., San-ying, Z., Lu-feng, Y., & Sugita, S. (2004). Concrete with highly active rice husk ash. Journal of Wuhan University of Technology-Mater. Sci. Ed., 19(3), 74-77.

[8] Rao MC, Bhattacharyya SK, Barai SV. Influence of field recycled coarse aggregate on properties of concrete. Mater Struct 2011; 44:205–20.

[9] Tam VWY, Gao XF, Tam CM. Microstructural analysis of recycled aggregate concrete produced from two-stage mixing approach. Cem Concr Res 2005; 35(6):1195–203.

[10] Tavakoli, M., and Soroushian, P. (1996). “Strength of recycled aggregate concrete made using filed-demolished concrete as aggregate.” ACI Material Journal, 93(2), 178 – 181.

[11] Xiao JZ, Li WG, Poon CS. Recent studies on mechanical properties of recycled aggregate concrete in China—A review. Sci China, Technol Sci 2012;55 (6):1463–80.