Scholars Journal of Engineering and Technology (SJET) **ISSN 2321-435X (Online)**
Sch. J. Eng. Tech., 2014; 2(5B):750-754 **ISSN 2347-9523 (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Review Article

A Review on Compressive and Tensile Strength of Concrete Containing Rice Husk Ash and Coir Fiber

Chirag.D.Magnani[1], Hirak.S.Shah[2], Jay.J.Lad[3], Darshan Mali[4], Vatsal. N. Patel*[5]
[1-4]B.E.Student in Civil Engg., [5]Associate professor, Department of Civil Engineering, A. D. Patel Institute Of Technology, New Vidyanagar, Anand,Gujarat, India

***Corresponding author**
Prof. Vatsal. N.Patel
Email: vatsalp1976@gmail.com

Abstract: Cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of green house gases, such as CO_2, to the atmosphere. Among the greenhouse gases, CO_2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In order to address environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. Consequently extensive research is on going into the use of cement replacements, using many waste materials and industrial by products. To reduce the impact on the environment due to industrial and agricultural waste products such as Rice Husk Ash (RHA) and coconut fibers (COIR) which are the waste products of paddy and agricultural industry. Use of these materials in concrete not only improves the strength of concrete but also leads to the proper disposal of these materials, resulting in reducing the impact of these materials on environment. It is found that the rice husk ash is obtained by burning of rice husk in a controlled way, which is highly reactive pozzolonic material and the coir having excellent mechanical and physical properties to be utilized in effective way in development of composite materials. This paper describes about the results obtained from various research done on the partial replacement of cement with RHA and COIR in concrete.
Keywords: Rice husk ash, coconut fiber, Global Warming, Green house gas, Carbon Dioxide

INTRODUCTION

Due to fast growth in population, the amount and type of waste materials have increased accordingly. Many of the non-decaying waste materials will remain in the environment for hundreds, perhaps thousands of years. The non-decaying waste materials cause a waste disposal crisis, thereby contributing to the environmental problems. The environmental impact can be reduced by making more sustainable use of this waste. This is known as the waste hierarchy shown in Fig.1. The aim is to reduce, reuse, or recycle waste, the latter being the preferred option of waste disposal.

Fig-1: waste hierarchy

With the increase in growth of population in country, the need to provide a decent and affordable accommodation to the people as part of the national economic strategy, i.e, eradication of poverty and improving the living quality of the people is seriously looked into. However, in the building of houses (low-cost), the availability of building material which is cheap and abundant is of paramount importance. To overcome this problem, the development of new construction materials, which must be inexpensive and require very little energy to produce, must be researched [17]. Considerable efforts has been taken worldwide to utilize local natural waste and by-products materials as supplementary cementing materials to improve the properties of cement concrete as well as the use of these materials leads to the proper disposal of natural waste results in the less impact on environment in order to reduce the loss due to improper disposal of the waste [1]. Concrete is a widely used construction material for various types of structures due to its structural stability and strength. All the materials required producing such huge quantities of concrete come from the earth's crust. Thus, it depletes its resources every year creating ecological strains. On the other hand, human activities on the Earth produce solid waste in considerable quantities of over 2500/MT per year, including industrial wastes, agricultural wastes and wastes from rural and urban societies. Recent technological development has shown that these materials are valuable as inorganic and organic resources and can produce various useful products. Amongst the solid wastes, the most prominent ones are fly ash, blast furnace slag, rice husk, coir fiber and demolished construction materials. The use of by-products is an environmental friendly method of disposal of large quantities of materials that would otherwise pollute land, water and air. Most of the increase in cement demand will be met by the use of supplementary cementing materials. Rice milling generates a by-product known as husk as shown in Fig.2. This surrounds the paddy grain. During the milling of paddy about 78 % of weight is received as rice, broken rice and bran. The rest 22 % of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter which burns up and the balance 25 % of the weight of this husk is converted into ash during the firing process, which is known as rice husk ash (RHA).The burning temperature is within the range of 600 to 850 degrees. The ash obtained is ground in a ball mill for 30 minutes. This RHA in turn contains around 85%-90% amorphous silica. So for every 1000 kg of paddy milled, about 220 kg (22%) of husk is produced, and when this husk is burnt in the boilers, about 55 kg (25%) of RHA is generated. India is a major rice producing country, and the husk generated during milling is mostly used as a fuel in the boilers for processing paddy, producing energy through direct combustion and / or by gasification. About 20 million tons of RHA is produced annually. This RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped. Lots of ways are being thought of for disposing it by making commercial use of this RHA.[19] Coconut fibre shown in Fig.3 is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fibre is Coir, Cocos nucifera and Arecaceae (Palm), respectively. There are two types of coconut fibres, brown fibre extracted from matured coconuts and white fibres extracted from immature coconuts. Brown fibres are thick, strong and have high abrasion resistance. White fibres are smoother and finer, but also weaker. Coconut fibres are commercial available in three forms, namely bristle (long fibres), mattress (relatively short) and decorticated (mixed fibres). These different types of fibres have different uses depending upon the requirement. In engineering, brown fibres are mostly used According to official website of International Year for Natural Fibres 2009, approximately, 500 000 tonnes of coconut fibres are produced annually worldwide, mainly in India and Sri Lanka. Its total value is estimated at $100 million. India and Sri Lanka are also the main exporters, followed by Thailand, Vietnam, the Philippines and Indonesia. Around half of the coconut fibres produced is exported in the form of raw fibre [4].Fig.4 shows the longitudinal cross section of coconut fibres.

Fig-2 :Rice-husk ash

Fig-3: Coconut tree, coconut, coconut fiber

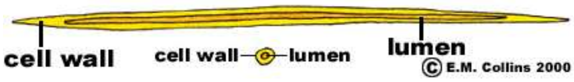

Fig-4: Longitudnal cross-section of coconut fiber.

Summary of previous research

Pravin.V.Domke [1], In his experimental work replaced cement by 15% RHA and adding 3% coir in M_{20} grade concrete gave tensile strength = 7.8N/mm^2 Compared to 4.2 N/mm^2 of ordinary mix concrete. Further adding 17.5% RHA +4% Coir Fiber gave optimum compressive strength 24.5 N/mm^2 compared to 23.55 N/mm^2 normal concrete at 7th day. Pravin.V.Domke [1], In his experimental work replaced cement by 3% coir fiber in M_{20} grade concrete and got tensile strength 7.5 N/mm^2 and compressive strength 41.1 N/mm^2,46.6 N/mm^2 at 7th and 28th day. Compared to 4.2 N/mm^2 tensile strength and 23.55 N/mm^2, 40 N/mm^2 compressive strength of ordinary mix concrete.

Pravin.V.Domke, et.al [2] In their experiment replaced cement by 15% rice husk ash and got tensile strength 6.51 N/mm^2 compared to 4.2 N/mm^2 tensile strength of ordinary mix concrete of grade M_{20}. Further, replacing cement by RHA in various percentage showed a decrease in compressive strength.

Satish D. Kene,, et.al [3] In their experimental work replaced cement by 30% rice husk ash and got tensile strength 2.26 N/mm^2 and compressive strength 18.33 N/mm^2 at 7^{th} day as compared to 6.5 N/mm^2 tensile strength and 24.56 N/mm^2 compressive strength of normal concrete of M_{25} grade.

Majid Ali, [4] In his experimental work replaced cement by 2% coir fibre and got tensile strength 3.54 N/mm^2 and compressive strength 24.35 N/mm^2 compared to normal concrete with tensile strength 2.88 N/mm^2 and compressive strength 21.42 N/mm^2.

Sandesh. D.Deshmukh, et.al [5], In their experimental work replaced cement by 2.5%, 5%, 7.5%, 10%, 12.5%, 15%, 17.5%, 20% and got reduction in tensile strength at 28 day for M_{20} and M_{30} grade concrete.

Khusbu Rajhans, et.al [6], In their experimental work replaced cement by rice husk ash in various percentage of 6,12,18,24 showed same tensile strength of concrete. An increase in compressive strength was observed compared to normal concrete by adding 12% rice husk ash, and further adding RHA, compressive and tensile strength decreased.

M. Sivaraja, et.al [7], In their experimental work replaced cement by 1.5% Rice Husk and tensile strength 3.48 N/mm^2 and compressive strength 27.98 N/mm^2 compared to 2.86 N/mm^2 tensile strength and 27 N/mm^2 compressive strength of normal concrete.

Guilherme chagas cordeiro, et.al, [8], In their experimental work replaced cement by 10%,15%,20% rice husk ash gives tensile strength 5.9 N/mm^2,5.7 N/mm^2, 5.8 N/mm^2 compared to 5.5 N/mm^2 normal concrete.

Felicity Aku, et.al, [9], In their experiment made mortar with 10% cement, 89.8% sand and 0.2% coir fibre gave tensile strength 3.46 N/mm^2 and compressive strength 625 psi compared to 2.34 N/mm^2 tensile strength and 516 psi of normal concrete.

Al- Abdaly, et.al,[10], In their experimental work replaced cement by rice husk ash (RHA) in two percentages (5, 7.5)% and found that the addition of RHA to concrete caused a deficiency by about (16-34) % for compressive strength , (11-16)% for splitting tensile strength , (4-11) % for modulus of elasticity and (7-43) % for drying shrinkage.

Anju Mary Ealias, et.al, [11], In their experimental work replaced cement by 3% coir fibre and adding 10% coconut shell by weight of aggregate in M_{30} grade concrete gave tensile strength 1.23 N/mm^2,1.91 N/mm^2, & 2.1 N/mm^2 and compressive strength 11.34 N/mm^2,18.38 N/mm^2,20.47 N/mm^2 at 7^{th},14^{th},& 28^{th} day compared to 1.93 N/mm^2,2.51 N/mm^2, & 3.71 N/mm^2 tensile strength and 28.45 N/mm^2,31.62 N/mm^2,36.06 N/mm^2 compressive strength at 7^{th},14^{th}, & 28^{th} day normal concrete.

G.A. Habeeb, et.al,[12],In their experimental work replaced cement by 20% RHA in concrete of different grade f1,f2,f3 i.e, 180, 270 and 360 minutes grinding gave tensile strength 2.9 N/mm^2,3.2 N/mm^2, 3.2 N/mm^2 and compressive strength 40.6 N/mm^2, 41 N/mm^2, 41.7 N/mm^2 compared to tensile strength 2.6 N/mm^2 and compressive strength 39.6 N/mm^2 of normal Concrete at 28^{th} day.

Alireza Naji Givi, et.al,[20], In their experimental work replaced cement by 20% RHA in concrete of different particle size f1,f2,f3 i.e, 31.3, 18.3, 11.5 mm gave tensile strength 2.9 N/mm^2, 3.2 N/mm^2, 3.2 N/mm^2 compared to 2.6 N/mm^2 of normal concrete at 28^{th} day.

C. Mathiraja, [13],In his experimental work replaced cement by 20% bottom ash and 75% manufactured sand in place of natural sand, (1) Adding 1% coir fiber gave tensile strength 4.1 N/mm^2 (2) Adding 0.5% coir & 1.25% steel fiber gave 5.11n/mm^2 tensile strength compared to 2.02 N/mm^2 tensile strength of normal concrete.

Dr.M.Sivaraja, et.al, [14], In their experimental work added 1% coir fibre with aspect ratio 90 in concrete and got tensile strength 3.98 N/mm^2 compared to 2.86 N/mm^2 of normal concrete. They also added 1.5% coir fibre with aspect ratio 90 in concrete and got compressive strength 29.76 N/mm^2 compared to 27.33 N/mm^2 of normal concrete.

A. A., Ramezanianpour, et.al,[15], In their experimental work added 15% RHA in place of cement in concrete and got tensile strength 2.95 N/mm^2, 4.39 N/mm^2, 5.62 N/mm^2 and compressive strength 34.2 N/mm^2, 46.9 N/mm^2, 63.2 N/mm^2 at 7^{th} , 28^{th}, 90^{th} day, compared to 2.65 N/mm^2, 3.87 N/mm^2, 4.56 N/mm^2 tensile strength and 30.2 N/mm^2, 40.3 N/mm^2, 50.3 N/mm^2 compressive strength of normal concrete at same days.

A. E. Abalaka, [16], In his experimental work replaced cement by rice husk ash with different % and different water/cement ratio. (1) replacing cement by 5% RHA and w/b ratio 0.35 gave tensile strength 3.812 N/mm^2 compared to 3.709 N/mm^2 normal concrete. (2) replacing cement by 5% RHA and w/b ratio 0.4 gave tensile strength 4.097 N/mm^2 compared to 3.553 N/mm^2 normal concrete. (3) replacing cement by 5% RHA and w/b ratio 0.45 gave tensile strength 3.591 N/mm^2 compared to 3.517 N/mm^2normal concrete. (4) replacing cement by 15% RHA and w/b ratio 0.5 gave tensile strength 3.694 N/mm^2 compared to 2.618 N/mm^2 normal concrete (5) replacing cement by 10% RHA gave tensile strength 3.834 N/mm^2 compared to 3.297 N/mm^2 normal concrete. On further increase of rha % decreased the tensile strength of concrete.

Kartini, et.al, [17], In their experimental work replaced cement by 20% RHA in M_{30} grade concrete and got reduction in tensile strength at 7^{th} day, but it became equal at 28^{th} & 90^{th} day. Similarly, replacing cement by 20%,30% RHA in M_{30} grade concrete showed reduction in compressive strength at 7^{th} and 28^{th} day.

Sandesh D. Deshmukh, et.al,[18], In their experimental work replaced cement by 2.5 %, 5 %, 7.5 %, 10 %, 12.5 %,15 %, 17.5 % & 20 % RHA and got reduction in tensile and compressive strength of concrete compared to normal concrete.

CONCLUSION

Rice husk ash and coir fiber can be considered as a suitable replacement of cement in concrete

- Making concrete stronger in compression and tension.
- Making concrete more economical.
- Proper utilization of agricultural waste, reducing the impact on environment.

References

1. Domke PV; Improvement In The Strength Of Concrete By Using Industrial And Agri-Cultural Waste. IOSR Journal Of Engineering Apr, 2012; 2(4):755-759.
2. Domke PV, Deshmukh SD, Kene SD, Deotale RS; Study Of Various Charac-Teristic Of Concrete With Rice Husk Ash As A Partial Replacement Of Cement With Natural Fibers (Coir). International Journal Of Engineering Research And Applications, 2011; 1(3): 554-562.
3. Kene SD, Domke PV, Deshmukh SD, Deotale RS; Assessment Of Concrete Strength Using Flyash And Rice Husk Ash. International Journal Of Engineering Research And Applications, 2011; 1(3):524-534.
4. Ali M, Coconut Fibre – A Versatile Material And Its Applications In Engineering. Journal of Civil Engineering and Construction Technology, 2011; 2(9):189-197.
5. Deshmukh SD, Domke PV , Kene SD , Deotale RS; Experimental Study On Strength Of Concrete By Using Artificial Fibers With Rice Husk Ash. International Journal Of Engineering Research And Applications, 2011; 1(3):571-581.
6. Rajhans K, Sharma CR; Studies On Concrete Characteristic Strength Using Fly Ash And Rice Husk Ash. Int. Journal Of Engineering Research And Applications, 2014; 4(2):40-44.
7. Sivaraja M, Kandasamy S; Potential Reuse of Waste Rice Husk As Fibre Composites In Concrete. Asian Journal Of Civil Engineering (Building And Housing), 2011; 12(2):205-217.
8. Chagas G, Dias CR, Filho T, De E, Fairbairn MR; Use Of Ultrafine Rice Husk Ash With High-Carbon Content As Pozzolan In High Per-Formance Concrete. Materials And Structures, 2009;42:983–992.
9. Amezugbe FA; The Performance Of Natural And Synthetic Fibers In Low Strength Mortar: A Pilot Study Of Six Selected Fibers. A Thesis Presented To The Graduate School Of The University Of Florida In Partial Fulfillment Of The Requirements For The Degree Of Master Of Science In Building Construction, 2013.
10. Al- Abdaly NM; Drying Shrinkage Cracking Of High Strength Concrete. M.Sc Thesis, University Of Babylon. 2007.
11. Ealias AN, Rajeena AP, Sivadutt S , John L, Paul A; Improvement Of Strength Of Concrete With Partial Replacement Of Course Aggregate With Coconut Shell And Coir Fibres", Iosr Journal Of Mechanical And Civil Engineering, 2014;11(3):16-24.
12. Habeeb GA, Fayyadh MM; Rice Husk Ash Concrete: The Effect Of Rha Average Particle Size On Mechanical Properties And Drying Shrinkage. Australian Journal Of Basic And Applied Sciences, 2009; 3(3): 1616-1622.
13. Mathiraja C; A Study On Concrete Using Bottom Ash, Manufacturing Sand And Hybrid Steel And Coir Fibres", Iosr Journal Of Mechanical And Civil Engineering, 2013; 10(1):55-57.
14. Sivaraja M ; Application Of Coir Fibres As Concrete Composites For Disaster Prone Structures. R&D Project Report , Central Institute Of Coir Technology Coir Board Peenya Industrial Area, Bangalore, 2010.
15. Ramezanianpour A, Khani M, Ahmadibeni G; The Effect Of Rice Husk Ash On Mechanical Properties And Durability Of Sustainable Concretes. International Journal Of Civil Engineerng, 2009; 7(2).
16. Abalaka E; Strength And Some Durability Properties Of Concrete Containing Rice Husk Ash Produced In A Charcoal Incinerator At Low Specific Surface. International Journal Of Concrete Structures And Material, 2013; 7(4):287–293.
17. Kartini K, Mahmud HB, Hamidah MS; Strength Properties Of Grade 30 Rice Husk Ash Concrete. 31st Conference On Our World In Concrete & Structures: 16 - 17 August 2006, Singapore.
18. Deshmukh SD, Domke PV, Kene SD, Deotale RS; Experimental Study On Strength Of Concrete By Using Artificial Fibers With Rice Husk Ash, International Journal Of Engineering Research And Applications, 2011; 1(3):571-581..

19. Rao PP, Kumar AP, Singh BB; A Study On Use Of Rice Husk Ash In Concrete. International Journal of education and applied research, 2014; 4(2):75-81.
20. Givi AN, Abdul S, Nora RS , Mohamad AA, Salleh AM; Contribution Of Rice Husk Ash To The Properties Of Mortar And Concrete: A Review. Journal Of American Science, 2010;6(3): 157-165.