STM JOURNALS

Journal of
Polymer & Composites

ISSN: 2321-2810 (Online)
ISSN: 2321-8525 (Print)
Volume 12, Special Issue 5, 2024
DOI (Journal): 10.37591/JoPC

http://engineeringjournals.stmjournals.in/index.php/JoPC/index

Research JoPC

Influence of Rice Husk Ash and Granite Powder on Strength Properties of Concrete

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Abstract

Concrete is the mostly utilised material in the field of Civil Engineering. As its consumption is huge in amount and so the scarcity of the raw materials has become a major issue. The important components of concrete are binding material along with the aggregates. Alternative materials are chosen for the replacement of cement to achieve sustainable concrete. Along with cement replacing materials, reusable wastes are also adopted to utilise in concrete as a substitute of sand. The paper deals with the utilisation of waste products rice husk ash from agricultural industry and granite powder from granite industry respectively in concrete to develop a novel concrete with sustainable characteristics. Cement is replaced by rice husk ash at constant percentage of 20% and sand is replaced by granite powder at various percentages 0, 10, 20, 30, 40 and 50 % respectively. The hardened tests on concrete specimens are performed and strengths values are compared to conclude the optimum content of granite powder. Remarkable properties are attained by converting the natural agricultural wastes to reusable raw material for concrete.

Keywords: Rice husk ash, flexural strength, granite powder, split tensile strength, compressive strength

INTRODUCTION

Construction field plays a vital role in development of a country in various aspects. As the demand for the construction materials increased because of rapid growth of construction technology, thus resulting in the scarcity of the raw materials. Hence several alternative materials are chosen and tested for suitability for adding or replacing the raw materials of concrete. These alternative materials include wastes from industries as well as by products [18]. India is a country having agriculture as main backbone when compared to other aspects. Paddy farms are mostly cultivated crops in India which results in the huge production of rice. Thus generation of rice husk is more due to consumption of rice by the people. The material rice husk itself cannot be decomposed into earth and it also causes harmful effects. Hence it can be burnt and utilised for concrete by replacing the cement which lowers environmental pollution [12]. The burnt powdered form of rice husk can be termed as ash that can be replaced in cement due to silica content. The other material considered in the present study is granite powder, which is also a waste product obtained from several granite industries. The less availability of natural fine aggregate sand resulted in adoption of different alternatives to attain sustainability [7]. Utilisation of granite powder in concrete also affects workability aspects by filling the pores and increasing the density of concrete. The main theme of the work is to attain the strength characteristics of M20 concrete by using the alternate materials as substitutes for cement and fine aggregate to produce an innovative concrete.

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Received Date: April 23, 2024
Accepted Date: May 30, 2024
Published Date: July 25, 2024

Citation: G. Gowrisanakra Rao, G. Prasanna Kumar, G. Anil Kumar, Krupasindhu Biswal. Influence of Rice Husk Ash and Granite Powder on Strength Properties of Concrete. Journal of Polymer & Composites. 2024; 12(Special Issue 5): S133–S138.

LITERATURE REVIEW

Felixkala et al. (2010) had tested the concrete specimens for mechanical properties by utilising various materials in the place of cement and sand. Granite powder was replaced in the percentages of 0, 25, 50, 75 and 100 % and cement with 10% fly ash, 7.5% silica fume and 10% slag [6]. Kanmalai Williams et al (2008) have investigated the strength properties, elasticity modulus, shrinkage parameters and penetration aspects of concrete developed by granite powder, supplementary cementitious materials. The combined effect of these materials on concrete was analysed for various curing periods and the concrete had shown better performance at 25 % replacement [17]. Divakar et al. (2012) have studied the strength effect of concrete with utilisation of fine granite powder. Granite powder at different proportions of 5, 15, 25, 35 and 50% and strength parameters of concrete were investigated from the destructive tests and are compared with the normal concrete [4]. Elangovan (2015) had presented the possible uses of granite dust powder in concrete by conducting tests on fresh and hardened concrete. The optimum content of granite dust was found to be at 15 % replacement [5]. Allam et al. (2016) have studied the workability of concrete with granite waste powder. The optimum content of granite waste was found at 5% addition by showing minimum voids in SEM images resulting in increase of density [1]. Chiranjeevi reddy et al. (2015) had prepared concrete by granite powder by replacing cement at different propositions of 2.5, 5, 7.5 and 10% and tests for evaluating parameters of strength. The effective replacement percentage of granite powder was attained at 10 % [2]. Marthong et al. (2012) had compared the effects of husk ash of rice on strength properties of concrete. Cement was partially replaced by rice husk ash at various percentages and the strength properties were dominating the normal concrete at 20 % replacement which was observed from the results obtained [15]. Jongpradist et al. (2018) had examined the effect of cement by using rice husk ash in deep cement mixing technique. The optimum content of rice husk ash used for stabilisation of clay with cement for attaining high-strength mixture was obtained at 20% [13]. Arvind Kumar et al. (2016) had studied properties of concrete with rice husk ash as replacement of cement by 20% and the strength parameters were compared with normal concrete for various curing periods [14]. Habeeb et al. (2010) had investigated properties of rice husk using XRD analysis to study silica content. The concrete with rice husk ash had shown improvement in strength up to 20 % replacement [8]. Vashisht Patil et al. (2020) had utilised the rice husk ash as replacement material for cement at various percentages by weight. The optimum content was decided at 15 % based on the strength parameters obtained [16].

PROPERTIES OF MATERIALS

- Priya Cement of type OPC 53 grade having 3.10 specific gravity.
- Naturally obtained river sand of 2.61 specific gravity.
- Coarse aggregate of 20 mm having specific gravity of 2.76.
- Granite powder having specific gravity of 2.56 is used.
- Rice Husk Ash obtained as a waste product from Rice Industries is considered in the study.

METHODOLOGY AND EXPERIMENTAL PROGRAM

The methodology involved is developing sustainable concrete using the rice husk ash and granite powder by considering M20. The properties of all the raw materials are performed as per IS Codal conditions [10]. Cement is replaced by rice husk ash by weight at a percentage of 20 and sand is replaced by granite powder at various percentages from 0 to 50 % at regular interval of 10%. The experimental program constitutes of casting of various specimens such as cubes, cylinders and prisms at 7, 14 and 28 days of curing periods [19]. Cube specimens of size 150×150×150 mm, cylinder specimens of size 150×300 mm and prism specimens of size 500×100×100 mm respectively [3] . The optimum content of granite powder is determined form strength tests and mix design of M20 is as per IS 10262:2019 and mix proportion is 1:1.5:3 [9].

RESULTS AND DISCUSSIONS

The designations of various mixes are represented as MRG0, MR20G10, MR20G20, MR20G30, MR20G40 and MR20G50 for 0, 10, 20, 30, 40 and 50 % replacement.

The values of compressive, split tensile and flexural strengths of M20 grade concrete mixes with rice husk ash, granite powder are presented in Table 1, Table 2 and Table 3 respectively [11]. Similarly their variations are shown in Figure 1, Figure 2 and Figure3 respectively.

MR20G30 mix has exhibited highest compressive strength for curing period of 28 days. The concrete mix with 30 % granite powder is concluded as the optimum mix among all the other mixes. The percentage increase in strength at compression of MR20G30 is by 13.92 % when compared to normal concrete MRG0.

Table 1. Values of average compressive strength of concrete at different curing periods

Mix Type	**Compressive strength (MPa)**		
	Age of curing (days)		
	7	*14*	*28*
MRG0	13.89	16.36	27.22
MR20G10	13.90	17.41	28.36
MR20G20	14.10	18.60	28.95
MR20G30	14.32	19.73	31.02
MR20G40	14.03	18.04	27.30
MR20G50	12.96	16.94	24.10

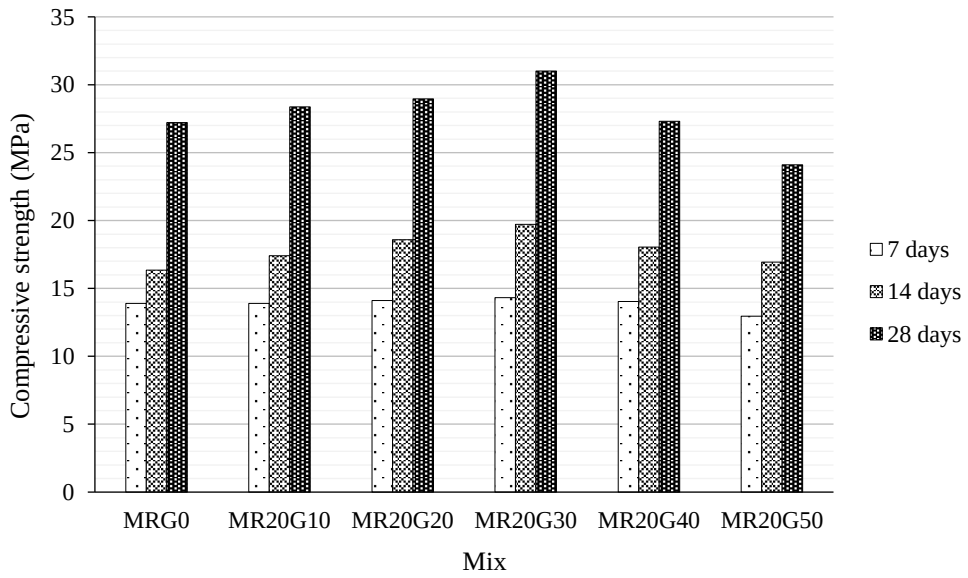

Figure 1. Variation of compressive strength of concrete at different curing periods.

Table 2. Values of average split tensile strength of concrete at different curing periods.

Mix Type	**Split tensile strength (MPa)**		
	Age of curing (days)		
	7	*14*	*28*
MRG0	1.61	1.73	1.92
MR20G10	1.70	1.97	2.19
MR20G20	2.42	2.60	2.89
MR20G30	2.78	2.70	3.00
MR20G40	2.62	2.65	2.94
MR20G50	1.96	2.00	2.23

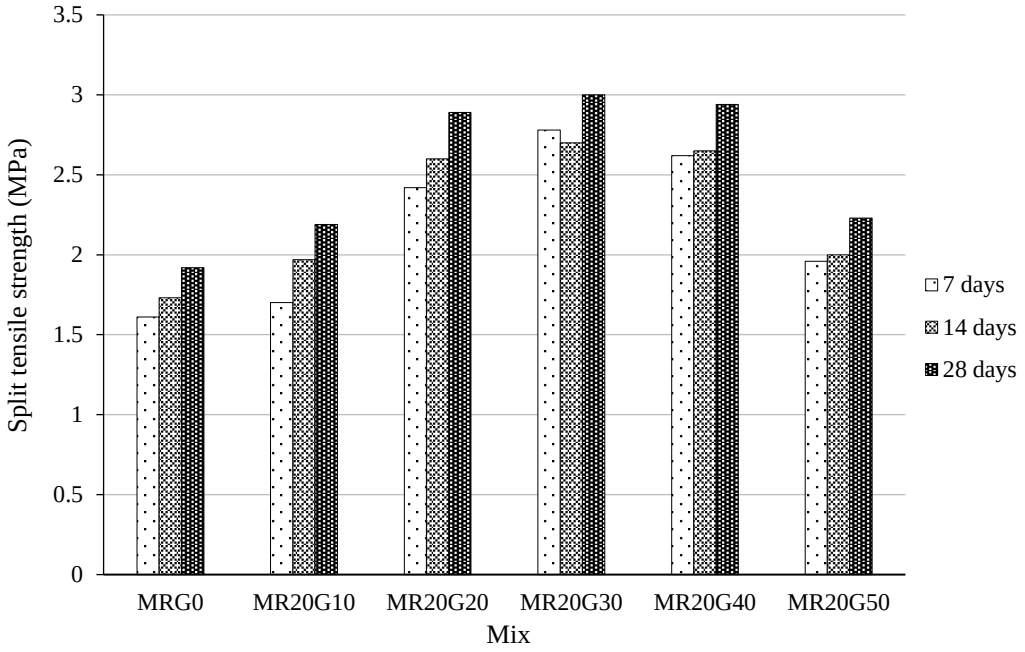

Figure 2. Variation of split tensile strength of concrete at different curing periods.

Table 3. Values of average flexural strength of concrete at different curing periods.

Mix Type	**Flexural strength (MPa)**		
	Age of curing (days)		
	7	*14*	*28*
MRG0	1.89	3.26	3.34
MR20G10	2.01	3.65	3.86
MR20G20	2.50	3.82	3.94
MR20G30	2.71	3.94	4.12
MR20G40	2.90	3.97	3.88
MR20G50	2.79	3.63	3.72

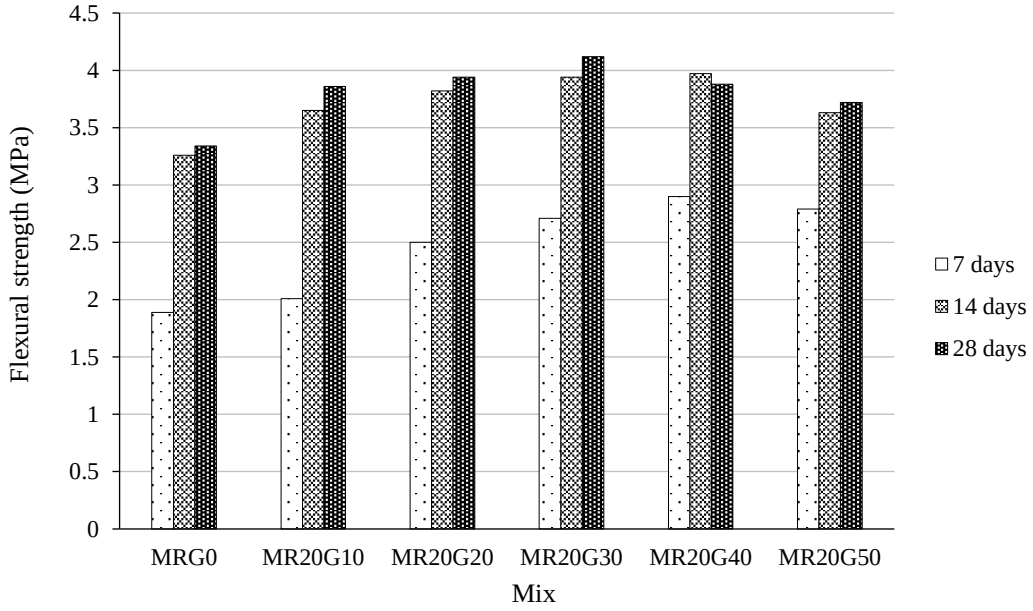

Figure 3. Variation of flexural strength of concrete at different curing periods.

Mix consisting of 30 % granite powder has shown the maximum strength and is considered as the optimum mix among all concrete mixes. The increase in strength of MR20G30 concrete mix is by 56.20 % when compared to concrete mix MRG0.

The concrete mix MR20G30 has exhibited high strength values in flexure. The increase in strength of MR20G30 concrete mix is by 23.35 % when compared to normal concrete.

The presence of pozzoloanic particles in rice husk ash has improved the strength values of concrete along with granite powder by providing sufficient CSH gel for the hydration process.

CONCLUSIONS

The following are the conclusions drawn from the research study:

- Combined utilization of waste products such as Rice husk ash and granite powder led to manufacture of sustainable concrete with improved strength properties. The presence of silica in the burst ash of rice husk has increased the strength of concrete by enhancing the hydration process.
- Granite powder with 30 % replacement has exhibited the optimum strength than the conventional concrete with 20 % rice husk ash.
- Utilisation of these waste materials as suitable alternatives for ingredients of concrete can induce the economic considerations and reduce the global issues by developing innovative concrete.

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