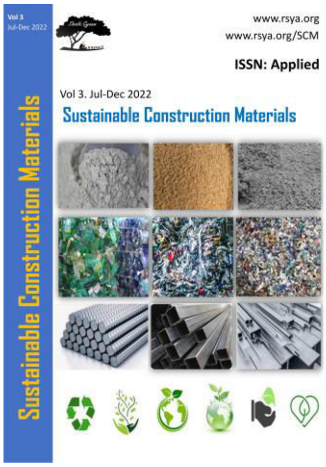

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Utilization of Red-Mud as a Partial Replacement for Cement in Concrete

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Abstract. Finding alternative materials that may be used to a significant extent is becoming increasingly important in the modern world, which features intense competition and heightened awareness of environmental issues. It is common knowledge that the aluminium manufacturing business in India generates a substantial amount of solid waste, also known as "red mud." During the process of refining alumina that Bayer developed, red-mud is produced. Because it contains a number of potentially hazardous components, dumping red mud can contaminate the ground and the water, in addition to covering up valuable property. By analysing the cementation behaviour of the material, it is possible to use red mud as a partial substitute for cement in mortar and concrete technologies. These technologies are used in construction activities. It is possible to save money by partially substituting cement with red mud, which is a waste product from the alumina industry and is available free of charge. As a result of the fact that wastes are no longer needed for any industrial processes, one innovative use for them in the field of civil engineering is as a raw material. Taking into account the cementitious behaviour of the red mud, an experiment was carried out with the purpose of partially substituting cement in concrete with red mud for varying percentages (0%, 5%, 10%, 15%, 20%, and 25%). Within the context of the mechanical strength of cement, research is conducted and information is provided on the behaviour of specimens of cement mortar under compression, tension, and flexure. The current article provides a summary of research on the use of red mud as a partial replacement for cement in mortar and concrete, as well as its impact on mechanical and durability elements of the material.

Keyword: Concrete, Ordinary Portland Cement, Red-mud, Mechanical Properties, Durability Properties.

INTRODUCTION

The global production of cement has increased by more than 100% over the past 15 years as a direct result of both industrialization and urbanisation. The most significant unintended consequence of these activities taking place all over the world is the generation of enormous quantities of industrial waste, as well as the problems involved with the effective management and disposal of these wastes. The second problem is that there is an inadequate supply of land, materials, and resources for ongoing development projects such as the construction of infrastructure. It is anticipated that annual aluminium production will be greater than 50 million tonnes in 2015[1–3]. Bauxite is responsible for more than 95 percent of all of the alumina that is generated globally. The approach developed by Bayer was utilised. The Bayer technique of producing alumina results in the generation of a significant quantity of Red-mud, which is a dust-like byproduct composed of high-alkaline bauxite. [4]–[7]. A form of industrial waste known as "red-mud" is generated at aluminium production sites all over the world. Red mud is a highly alkaline residue of the processing of bauxite. This is due to the presence of caustic soda in the red mud. (aluminum-bearing mineral) [8]–[10]. It has been gotten rid of. It is an issue, and it has a negative impact on the natural world. It is challenging to dispose of and harmful to the surrounding environment. Due to the fact that red mud has a complex combination of physical and chemical properties, the designers are faced with a challenging dilemma while trying to determine the safest and most cost-effective way to dispose of it. To conquer this obstacle, it is necessary to recycle it and use it in a variety of different parts of civil engineering [11–14]. Researchers led by B. Sawant and his colleagues investigated the potential of red mud to partially replace portland cement, up to a specified level [15]. The authors Prasad and Bishetti, et al. The aluminium sector, which produces an annual average of 3 million tonnes of red mud, presents a health risk due to the caustic nature of red mud and the contamination it causes in groundwater. A study was carried out to determine the effects of partially substituting red mud for cement in concrete at several percentages, as well as the influences on the strength and other properties of the concrete, while taking into account the cementitious behaviour of red mud[16], [17]. Both the Sucharitha patal and the B.K.pal: In order to provide an accurate picture of the state of industrial waste red mud, researchers investigated the amount of red mud that was produced for each tonne of alumina that was processed. This quantity shifts quite a bit depending on the particular bauxite ore that was mined and processed. Because of the potentially harmful nature of red mud, researchers have a tremendous difficulty when attempting to develop novel applications for it. Around the world, a variety of research projects are currently under way to investigate the storage, disposal, and usage of red mud. This study examined the current state of the problem as well as possible future developments in red mud characterization, disposal, assorted neutralising techniques, and application both globally and in India[18]. The Honorable M.P. Suresh Kumar and Mr. S.K. Gowtham: The potential application of red mud in concrete was investigated. In order to gain a deeper comprehension of the mechanical properties that cement concrete possesses, I conducted some tests using red mud as a replacement for cement. In order to investigate the mechanical properties possessed by cement concrete, I conducted various experiments in which I replaced a portion of the cement with red mud. The percentages of red mud partial replacement for concrete of grade M20 are as follows: 0 percent, 5 percent, 10 percent, 15 percent, and 20 percent. The findings of the experiments can be summarised as follows: By substituting ten percent of the cement in the mixture with red mud, we were able to improve the properties of the cured concrete [19].

MATERIALS USED

Cement

Binders are substances that can set and harden, and cement is one of those substances. It can also bond other building materials together. The most frequent types of cement are those that are utilised in the production of masonry mortar and concrete. Concrete is a mixture that consists of cement in addition to other components. During the course of the experiment, we used an aggregate that could be utilised in the production of a robust building material; specifically, ordinary Portland Cement (OPC) grade 43 in accordance with IS: 269-1976. The cement that was used is brand new and completely devoid of lumps. In order to validate that the cement fulfilled the requirements of the IS guidelines[12], [20], [21], it was put through a battery of rigorous examinations.

Water

When making concrete, it is typically possible to make use of drinkable water in the process. It is essential to purify the water by removing any organic impurities that may be present, such as acids, oils, alkalis, and vegetables. Concrete can also be broken down by waterlogged ocean floors. When it comes to concrete, water performs a few of different functions. To begin, it undergoes a chemical transformation when combined with the cement. Inert aggregates are used in the production of cement paste, which is then left suspended in the air until the paste has hardened completely. Second, it serves as a vehicle or lubricant when combined with fine aggregates and cement, which is an important function.

Fine Aggregate

River sand, which is easily available in the area, was collected specifically for the purpose of the experiment. The majority of the aggregate must be able to pass through a sieve with a particle size of 4.75 millimetres IS and can only contain as much material that is coarser as the standard permits. According to the source, the fine aggregate was produced by using coarse river sand that was readily available in the area. This sand was required to fulfil the standards of IS 383:1970's Grading Zone II. A specific gravity of 2.63 was determined to be associated with fine aggregate.

Coarse Aggregate

In the research, hard crushed granite stone and coarse aggregates that conformed to the IS: 383-1970 graded aggregate size of 10mm were used. A graded aggregate with a particular nominal size is what is meant when people talk about coarse aggregate. According to the calculations, the specific gravity of coarse aggregate comes in at 2.63. According to the results of an experiment that measured water absorption, coarse aggregate can take up 0.5 percent of the available water [22].

METHODOLOGY

In order to create concrete that can be worked while it is in its plastic stage and that will harden to achieve the desired properties, the design concrete mix requires determining the most practical quantity of concrete elements to use. This is done in order to produce concrete that can be worked while it is in its plastic stage. The objective of the design concrete mix is to determine the quantity of concrete materials that will produce a concrete that is workable while it is in its plastic stage and will harden to achieve the desired qualities. [23], [24] The most practical quantity of concrete materials will produce a concrete that is workable while it is in its plastic stage. The purpose of the experiment was to evaluate the characteristics of brick powder concrete and to investigate a number of important aspects, such as the compression strength, flexural strength, and split tensile strength of brick powder concrete with varied percentages of cement replacement. The control concrete mix design was developed using the Indian Standard as a reference point. M25 was the letter grade that was given. Brick powder was utilised as a substitute for cement in concrete at percentages ranging from 0 to 5 percent, 10 to 15 percent, 20 to 25 percent, and everywhere in between those two extremes.

Table 1: General Test of Materials

	Test Result (As per IS Code)	**Fine Aggregate**	**Coarse Aggregate**	**Cement**	**Red-mud**
a.	Specific Gravity	2.41	2.69	3.09	2.83
b.	Fineness Modulus	Zone II	Zone II	9%	-
c.	Water Absorption	1.2%	0.48%		
d.	Initial setting	-	-	38Min.	-
e.	Final setting	-	-	10Hrs.	-
f.	Consistency	-	-	32%	-
g.	pH	-	-	10-12.5	-

Table 2: Design Mix

Sr. No.	**Mixture ID**	**Replacement Proportion**	**Brick dust**	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	**Water**
1.	RMD_0	0%	-	400	748	1246	191
2.	RMD_5	5%	20	380	748	1246	191
3.	RMD_{10}	10%	40	360	748	1246	191
4.	RMD_{15}	15%	60	340	748	1246	191
5.	RMD_{20}	20%	80	320	748	1246	191
6.	RMD_{25}	25%	100	300	748	1246	191

RESULTS

Compressive Strength

Ascertaining a material's maximal compressive load capacity before fracture can be accomplished by mechanical testing. A gradually applied load compresses the test object, which is typically in the shape of a cube sample, prism, or cylinder, between the plates of the compression chamber. Here is a 150x150x150 mm cube that has been cast and cured. The outcomes are listed in the table below.

Split Tensile Strength

An essential property of concrete is its tensile strength, which is one of the most basic and important properties. Generally, concrete isn't considered suitable for use in structural applications due to its poor tensile strength and brittle nature. Because of this, concrete must be tested to determine the maximum load it can bear before it begins to break down. A 150 mm diameter and three hundred mm height cylinder specimen cast and hardened.

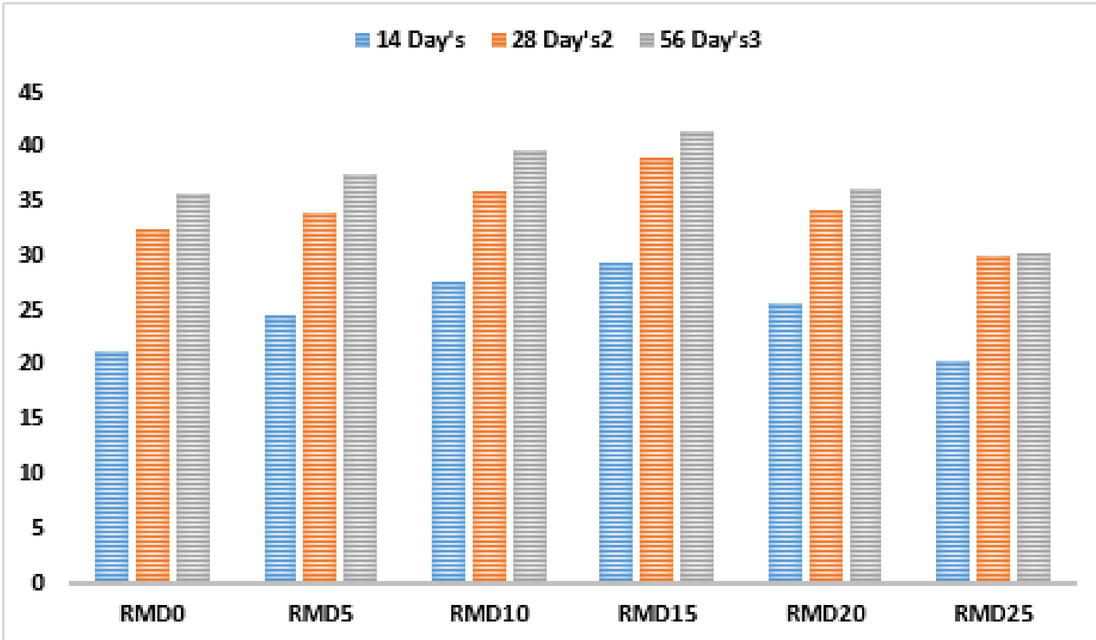

Figure 2: Compression test result

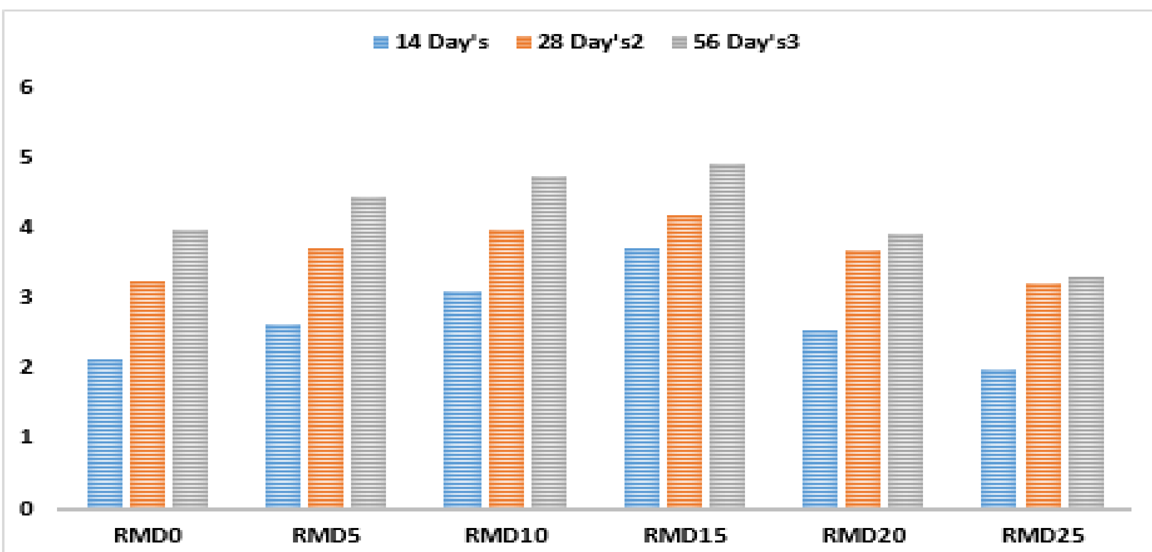

Figure 3: Split tensile result

Slump Cone Test

The slump flow value is a metric that is used to quantify how well a fresh mixture flows in unrestricted environments. It is a delicate test that is frequently supplied for all SCCs as the primary check that the new concrete consistency fits the specification. Often, this test is performed as part of the quality control process. The freshly poured cement concrete is subjected to this test in order to establish its degree of consistency. The findings are depicted in the graph that can be found below.

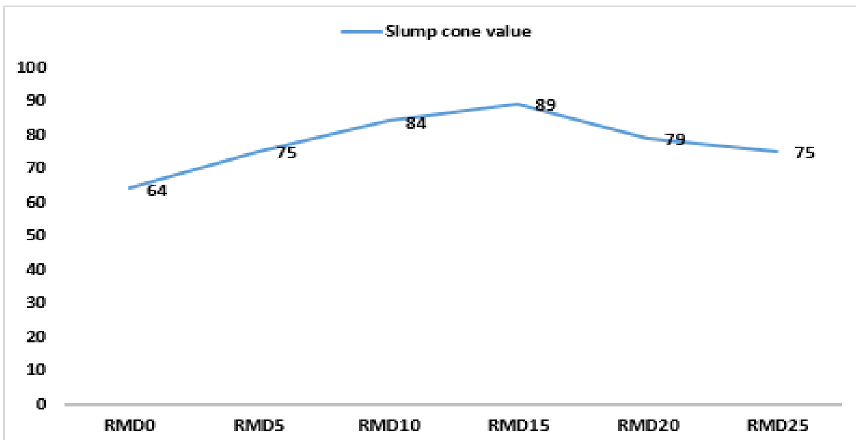

Figure 4: Slump Result

CONCLUSION

Due to the fact that the red mud that is produced during the process of producing alumina is so unattractive, it is a problem that affects the entire world. India is responsible for producing more than four million tonnes of red mud annually, whilst the global total is at 120 million tonnes. It is conceivable to decrease the risk of ground and surface water contamination by utilising red mud as a partial substitute for OPC cement. This would make it possible to use less cement overall. It is possible to reduce the amount of cement produced while also lowering CO_2 emissions by substituting red mud for cement in construction projects. When more than 20 percent of the red-mud mortar or concrete is replaced with cement, the compressive strength, tensile strength, and flexural strength are all reduced. Because of this, we may make the educated guess that a percentage of twenty percent is the correct amount of red-mud. It is possible to improve usage of waste products by switching to red mud as a cement alternative. The addition of the red mud had no impact on the quality of the cement; however, it accelerated the process of the cement setting and improved its compressive strength, which made the cement more durable and long-lasting. The red mud's inherent qualities undergo transformations as a result of the calcination process.

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