International Journal of Multidisciplinary Research And Studies

Available online at https://ijmras.com/

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND STUDIES

ISSN: 2640 7272

Volume:06; Issue:01 (2023)

STUDY ON CONCRETE WITH GRANITE POWDER REPLACEMENT WITH CEMENT, ANALYSIS COMPRESSIVE STRENGTH

RAJA SHAKYA[1]*, Prof. GAUTAM BHADOURIA[2]

[1]*Scholar, Civil department, Madav Institute of technology and science Gwalior. India*

[2]*Professor, Civil department, Madav Institute of technology and science Gwalior. India*

ABSTRACT

In the world of building, concrete is the material that holds the most weight. A sufficient quantity of synthetic materials, gravel, and water are required in order to produce it. The word "concrete" originates from the Latin word "concrete," which meaning "together it evolves." Cement, first class admixtures, and coarse admixtures are the three primary components that make up concrete. The science of determining relative quantities of concrete elements is known as concrete mix design. The goal of this science is to attain the desired qualities in the most cost-effective manner possible. Concrete is currently the second most important material in use around the globe, and the majority of businesses are looking for ways to produce more cost-effective concrete by switching from using cement to using cementation materials. The building industry makes extensive use of concrete, making it the single most significant material in this sector. As a result of urbanization, the amount of cement that is used in the building sector is continuously increasing.

Keywords: Grant Waste, Strength and Durability

INTRODUCTION

Around the world, there has been a lot of interest shown in the utilisation of waste products from the stone industry in the construction industry. This interest has been driven by the desire to reduce waste. Marble, granite, sandstone, limestone, slate, and slate are just few of the varieties of stone that can be found in India. One of the most important aspects of the stone industry in India is the business that deals in granite. Granite is a type of igneous rock that is formed when lava that is found deep within the earth slowly cools and crystallises into a stone that is known as granite. This process takes place over a long period of time. Because of its naturally high level of hardness and resilience, granite has been put to use throughout the course of human history as both a building material and an ornamental stone. In 2014, the World Natural Stone Association conducted a survey that revealed that the global production of granite stone was approximately 349 million square meters per year, with India ranking as the third-largest producer country of granite stone in the world, behind only China and Brazil. As of the first of April in the year 2015, India had a total of 46,320 million cum worth of granite resources in its possession. (IBM, 2018). Sadly, more than thirty percent of the granite that is cut and polished into beautiful blocks is now being thrown away as granite waste (GW) by businesses that work with granite. The term "granite waste" (GW) was coined to describe this practice. This residue was initially manufactured in the form of a wet slurry, and it is currently being disposed of in an improper manner at the local dumping sites. This waste product is regarded as being potentially dangerous. After a period of time, as a result of the evaporation of water that becomes airborne, it gradually transforms into a dry form, which ultimately leads to issues with one's health and is detrimental to the ecology of the area that surrounds it.

GRANITE PRODUCTION AND WASTE

A. Steps in the Production Process

During the processing of granite, which takes place in the Shaq Al-Thu'ban cluster, the raw stone block is sliced with diamond blades into tiles or slabs of various thicknesses (often 2 or 4 centimeters), depending on what the customer requires. This can take anywhere from a few minutes to several hours. The blades used to cut stone blocks into sheets of varying thickness are kept cool by water that is sprayed over them. The water also helps to absorb the dust that is produced during the process of cutting the stone blocks into sheets. This process results in the consistent production of a sizeable amount of wastewater on a regular basis. Because the water contains such a high concentration of alkali, it is not possible to recycle it because doing so would cause the polished slabs to have a lower degree of reflectivity if they were used. In large factories, the blocks are cut into slabs while the cooling water is held in pits until the dispersed particles settle (in tanks called sedimentation tanks), at which point the slurry is

RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

collected in trucks, disposed of on the ground, and allowed to dry out. Stone powder is carried along with this water in significant quantities by it. When the sludge is left out in the light for a period of time, it will eventually become dry, and the particles it contains will then become airborne. As a direct consequence of this, the surrounding area is experiencing higher levels of air pollution. Another kind of solid waste that is generated as a byproduct of the granite units is known as cutting waste. The generation of this garbage was caused by the process of chopping slabs down to the desired dimensions. After the stone has been cut to the required dimensions, the slabs are finished by polishing or texturing, depending on the requirements of the individual customer.

B. Waste Quantification

As a result of the fact that neither the Egyptian government nor any other organisation calculates or keeps track of the quantity of garbage generated by the granite industry in Egypt, accurate statistics regarding the amount of waste that is generated in that country are not available. The amount of waste that is produced during the processing step can range from as little as 39% in the production of 300mm x 20mm free length floor tiles to as much as 53% in the production of 305mm x 305mm 10mm tiles per 1 cubic metre. On the other hand, the amount of waste that is produced during the processing step can range from as little as 39% to as much as 53%. To put it another way, there is a direct correlation between the height of the product and the amount of waste that is eliminated as a result of its increased thickness. The findings of other sources indicate that between 20 and 25 percent of the granite that is mined ends up as powder after being processed into slurry. This is due to the fact that five millimetres of each granite slab are ground into powder during the process of cutting granite slabs with a thickness of twenty millimetres so that the slabs can be cut to the desired thickness. As it travels along, this powder incorporates itself into the water to create a slurry. It is possible to estimate that the industrial cluster of Shaq Al-Thu'ban generates somewhere in the neighbor hood of 800,000 metric tonnes worth of waste each and every single year based on the most conservative estimations of waste percentage. Granite extraction is one of the industries that has the most severe detrimental effects on the surrounding ecosystem.

C. Environmental Impact

RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

The process of cutting the stones results in the emission of heat in addition to slurry, rock fragments, and dust. As was indicated before, even if rubbish in general is made up of non-radioactive byproducts and does not, as a result, cause changes to the climate, it is nonetheless harmful to plant life and should be avoided. Granite waste cannot be considered inert on the basis of the findings of the conventional leaching tests (DIN 38414 or EN 12457) that have been carried out (that is, reactive). According to the results of these studies, the fines are composed of alkaline components that generate wastes with a high pH. (pH around 12). Due to the weathering of the worn steel grit and blades used in the processing of granite, a traceable but insignificant quantity of potentially harmful metals, such as chromium, are released throughout the operation. These metals may be detected. As a direct consequence of this, the area's ground and surface waters are both of poorer quality than they would otherwise be. Marbles often include minuscule quantities of the chemical elements CaO, MgO, SiO2, Al2O3, FeO3, Na2O, TiO2, and P2O5 in their overall makeup. During the cutting process, chemical compounds do not release any gases that contribute to warming the planet's climate or contributing to global warming. This is because water may be used in the cutting process to collect dust. Fine particles have the potential to contribute more to environmental pollution than other forms of marble debris, although this is only the case if they are not appropriately stored in sedimentation tanks and continuous use is not carried out. After the humidity has been reduced, the extremely minute particles are then in a better position to be dispersed when particular weather conditions, such as wind and rain, are present. CaCO3 is a compound that is frequently discovered in white dust particles; hence, these particles can be a source of visual pollution. Clay and soils have a high cation exchange capacity and may absorb a large proportion of heavy metals and cations like Ca, Mg, K, and Na; however, soils are not as efficient as granite small particles in retaining contaminants like Cl. Clay and soils also have a high cation exchange capacity.

Limited availability of natural aggregates

The production of concrete typically involves the utilization of sands and gravels derived from alluvial rivers. It is possible to obtain the components in large quantities, and they can be processed at a cost that is either low or moderate. This has led to their widespread application. In addition, the concrete that they produce is of a high quality because of the numerous physical characteristics that they possess, such as their form, gradation, and so on. These deposits are

 RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

the result of a natural process that occurred over a period of millions of years and resulted in their formation. These deposits have been mined to the point where there is nothing left to take. There is an inadequate supply of sand currently available. Sand mining has been carried out at an unsustainable rate, which has resulted in the depletion of ground water and creates problems for the local ecosystem. Several state governments have made it illegal to mine for a variety of reasons, some of which are listed below: I It is not good for the overall health of the ecosystem to remove an excessive amount of sand from the river bed as this can disrupt the natural balance of the river. (ii) The level of ground water is impacted as a result of the deep trenches that have been dug out in the river bed. (iii) Excessive sand raising is directly responsible for the erosion of the land that is in the surrounding area. It is a common sight to see the well foundations of bridges exposed extensively due to the excessive raising of sand that surrounds the substructure. This is caused by the excessive movement of sand. The integrity and safety of bridges are both put in jeopardy as a result of this.

Demand for Aggregate Made from Recycled Concrete (RCA)

It is against the law to collect sand from river beds in many different locations of the country. As a direct result of this, the characteristics of the sand and the material that is readily available have to be in accordance with the specifications.

Dams are a typical sight along the rivers of the world in today's day and age. As a consequence of this, these resources are running out at an extremely quick rate. There is a scarcity of sand that is of a very high quality. If an extensive distance needs to be travelled, there will be a rise in the costs connected with the transportation of high-quality sand due to the increased cost of fuel. Sand found in rivers may contain traces of minerals such as mica and coal, as well as fossils and a number of other types of organic pollutants. If the sand has more of these pollutants than a certain threshold level, then it cannot be utilised to make concrete since it does not meet the requirements for doing so. When the sand used to make concrete contains elements like bones, shells, or other biological matter of any kind, the durability of the concrete is reduced. In river sand, the inclusion of silt and clay reduces the strength of the concrete, helps the sand to keep its moisture content, and prolongs the amount of time it takes for the cement to cure. Sand that comes from rivers is called river sand.

RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

As a consequence of this, there is an urgent requirement to identify an alternative material that has the potential to serve as a replacement for sand. Utilizing recycled concrete aggregate is one solution that may be utilised. The general populace is under the impression that "Recycled concrete aggregate" (RCA) refers to rock quarry screens, which is an incorrect assumption. This is a common misunderstanding that needs to be addressed. One more variety of fine aggregate that can be used in the production of concrete is known as recycled construction aggregate (RCA). In contrast to this, the research conducted by the RCA proposes making use of demolished concrete by crushing it to produce a new product called sand, which has the potential to be utilised in structural concrete for things like bridges, pavements, and other similar things.

Aggregates Made from Recycled Concrete

In recent years, there has been a rise in interest in using recycled materials into the concrete-mixing process. In the years that are still to come, it's feasible that RCA may become more widespread. Depending on the specifics of the situation, the remaining concrete might have originated from any number of different locations. Work involving demolition is by far the most common sort of construction job. Many concrete structures, including buildings, bridges, sidewalks, and roads, are demolished after a predetermined amount of time has elapsed since the beginning of their service lives in order to make room for newer versions of those features or to make alterations to the surrounding landscape. Garbage may become piled up for a variety of reasons, some of which include natural disasters such as earthquakes, avalanches, and tornadoes. All of these variables lead to the production of vast amounts of waste concrete, which, for some reason, has to be handled.

According to a recent analysis, out of the two million tonnes of demolition and construction debris that are produced annually in the UK, only ten percent of that garbage is transformed into aggregate, and the majority of that aggregate is utilised as a fill material for highways. This garbage is a product of the construction industry. Recycled concrete aggregate (RCA) has the potential to be utilised in a variety of different applications in addition to its use in the construction of structures made of concrete. RCA has been the focus of a number of studies that have been carried out in order to investigate the effect that it has on the fresh and hardened properties of concrete. These studies were carried out in order to learn more about the impact that RCA has. On the other hand, there are not a whole lot of data that have been collected

RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

about the durability or performance of RCA concrete over a very extended length of time. Because of this, in addition to the widespread concern that the performance of the concrete may suffer as a result of using RCA, its application has tended to be limited in scope. This is why its application has tended to be limited.

OBJECTIVE OF THE STUDY

1. To compare the various features of modified concrete with granite powder replacement with cement, such as compressive Strength.
2. To study the impact on strength of concrete

RESEARCH METHODOLOGY

The experimental programme of the present study was carried out in order to investigate the effect of using granite powder as a component of cement in concrete and to investigate the fresh and harden properties of C20/25 as normal and C55/67 as high strength concrete in accordance with the testing procedures and specifications of the American Standard of Testing and Materials. The research was funded by the National Science Foundation.

The researcher only accessed locally available resources for the entirety of this investigation. Granite powder was used in place of cement in the fresh concrete mixes at the following percentages by volume: 0%, 5%, 10%, 15%, and 20%. A variety of concrete test specimens were cast and allowed to cure in order to investigate the strength and durability properties of the material.

DATA ANALYSIS

WORKABILITY OF FRESH CONCRETE

The results of the test of workability are presented in the table that can be found below.

Table 1: Slump height measures of C25 and C67 grade concrete

Percentage replacement	Slump height (cm)	
	C20/25	C55/67
0%	7.5	5
5%	6	4

 RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

10%	5	3.5
15%	5	3
20%	2.5	2

According to the findings, the slump height in C20/25 grade concrete and C55/67 grade concrete both decreased as the percentage of replacement increased. Granite powder's increased surface area contributed to an increase in surface hydration, which in turn led to an increase in water absorption, which, in turn, decreased the workability of concrete.

For C20/25 concrete, a medium workability is indicated by concrete containing up to 15% granite powder. This concrete can be utilised for a variety of purposes. When 20% of the original material was replaced, a discernible improvement in the slump was seen. On the other hand, the slump measurements for 0% replacement and 5% replacement in C55/67 concrete were not significantly different from one another. Testing the workability of higher strength concrete using the slump method was not as straightforward as testing the workability of normal strength concrete. The concrete that was produced is extremely sticky; this is due to the high quantity of cement as well as the admixture. Because of this, the accuracy of the slump test is reduced because it is not possible to remove the cone in a gentle manner in the vertical direction without twisting. Due to the fact that the concrete had piled up to the interior surface of the cone, removing the cone after the three layers of compaction proved to be a challenging task. As a result, a measure of workability that is more accurate is required in order to precisely investigate the variation in workability that occurs with each percentage of granite powder replacement.

According to the findings of subsequent research, an alternative method of measuring workability known as the compaction factor test is recommended for this kind of concrete. Because even if the concrete is stacked to the hoppers, the standard allows for the use of rodding to drop the concrete to the next hopper or to the lower cylinder. This is because the standard was created to accommodate the way that concrete is typically handled.

COMPRESSIVE STRENGTH

C20/25 as NSC

A test of the material's compressive strength was carried out after 7 and 28 days. Compressive strength increased by 13% and 9%, respectively, as a result of replacing 5% and 10% of the cement with granite powder, according to the results of the seventh day's experiment.

The results of the compressive strength test performed after 28 days revealed that the average compressive strength was still higher at 5% and 10% replacement, by 3.36% and 1%, respectively. However, when compared to the strength increase seen on day 7, the increase seen on day 28 is less significant. Which suggests that granite powder is more effective in gaining early strength than it is in gaining later strength.

Table 2: Test of the concrete's compressive strength using C20/25

Replacements	Cube No.	Compressive strength (Mpa)		Average strength (Mpa)	
		7th day	28th day	7th day	28th day
0%	1	28.206	36.481	29.576	34.995
	2	30.658	33.233		
	3	28.863	35.270		
5%	4	33.081	35.093	33.357	36.162
	5	36.177	38.867		
	6	30.814	34.526		
10%	7	31.566	34.747	32.209	35.277
	8	33.210	36.867		
	9	32.152	34.218		
	10	24.222	28.605		

RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

15%	11	28.488	29.350	27.696	29.630
	12	30.379	30.934		
20%	13	25.540	28.190	22.870	27.973
	14	20.517	28.292		
	15	22.554	27.437		

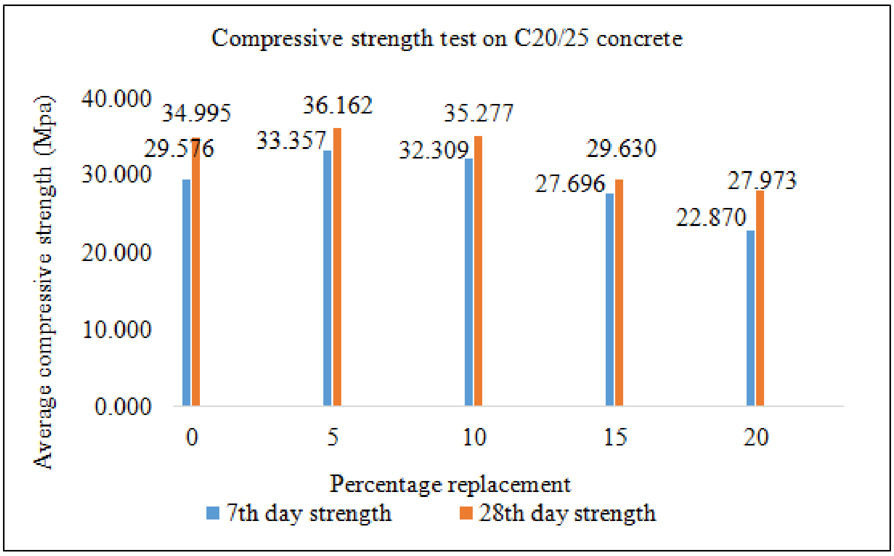

Figure 1: Compressive strength test result of C20/25 concrete

The formation of additional CSH gel and the microstructure improvement caused by filling of high fine granite powder are to thank for the increase in strength that was observed after the chemical reaction that took place between the calcium hydroxide in the cement and the granite powder. This reaction led to the formation of additional CSH gel. As a result, granite powder provides an enormous boost to the concrete matrix.

C55/67 as HSC

Tests of compressive strength were conducted over a period of 7 and 28 days. The results of the strength test performed on the seventh day revealed an improvement in strength of 5.86%

 RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

at 5% replacement. On the other hand, it went down by 10.85%, 19.51%, and 19.76% for 10%, 15%, and 20% correspondingly.

The results of the experiment after 28 days indicated that concrete cubes containing 5% granite powder had a strength that was still greater than the control. A 6.78% boost to its strength was given to it. The percentages of 10%, 15%, and 20% replacements each saw their strength drop by 3.75%, 6.47%, and 15.04% correspondingly. The reduction in cement content that occurs with increasing replacements is to blame for the weakening of the material.

Table 3: Test of the concrete's compressive strength using C55/67 mix

Replacement	Cube No.	Compressive strength (Mpa)		Average strength (Mpa)	
		7th day	28th day	7th day	28th day
0%	1	57.865	66.468	58.886	67.810
	2	61.261	67.760		
	3	57.533	69.202		
5%	4	64.240	74.960	62.340	72.409
	5	60.109	69.590		
	6	62.671	72.678		
10%	7	52.234	67.044	52.497	65.266
	8	52.057	64.012		
	9	53.199	64.741		
15%	10	47.935	64.178	47.397	63.420
	11	49.695	62.722		
	12	44.562	63.360		

 RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

20%	13	49.853	58.731	47.252	57.609
	14	46.465	54.958		
	15	45.439	59.138		

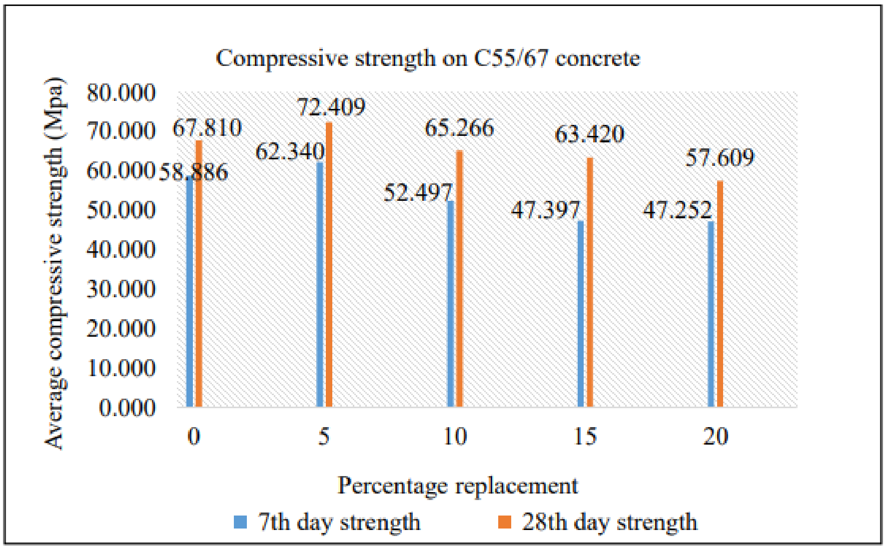

Figure 2: Compressive strength test result of C55/67 concrete

Because these tiny particles chemically react with calcium hydroxide at ordinary temperatures to generate compounds that have cementitious capabilities, the augmentation is made possible as a result of this reaction. When these components are used in concrete, the concrete will make effective use of the hydration products of Portland cement and will consume calcium hydroxide in order to build more cementing compounds. This will result in the concrete having a higher strength. If the concrete that contains these products is allowed to cure properly, the reaction products will partially fill in the space that was initially occupied by mixing water and that was not filled by the hydration products of cement. This will result in a reduction of the voids in the concrete as well as the permeability of the concrete to water and chemicals, which will result in an increase in the overall strength of the concrete.

FLEXURAL TENSILE STRENGTH

C20/25 as NSC

RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

The flexural strength test was carried out when the animals were 28 days old. According to the findings, concrete beams containing either 5 or 10 percent granite powder achieved higher levels of strength when compared to the control group by 6.34% and 7.94%, respectively. At 15% and 20% replacement, there was a 1% and 1.12% decrease in the material's flexural strength, respectively.

Table 4: Evaluation of the flexural strength of C20/25 concrete.

Sample No.	Replacement	Maximum load (N)	Length (mm)	Average width at fractured surface (mm)	Average depth at fractured surface (mm)	Modulus of rapture (Mpa)	Average strength (Mpa)
1	0%	31413	500	150	150	6.9807	7.1241
2		32704	500	150	150	7.2676	
1	5%	33654	500	150	150	7.4787	7.5758
2		34528	500	150	150	7.6729	
1	10%	33350	500	150	150	7.4111	7.6897
2		35857	500	150	150	7.9682	
1	15%	31945	500	150	150	7.0989	7.0524
2		31527	500	150	150	7.0060	
1	20%	31185	500	150	150	6.9300	7.0440
2		32211	500	150	150	7.1580	

 RAJA SHAKYA[1*]: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*

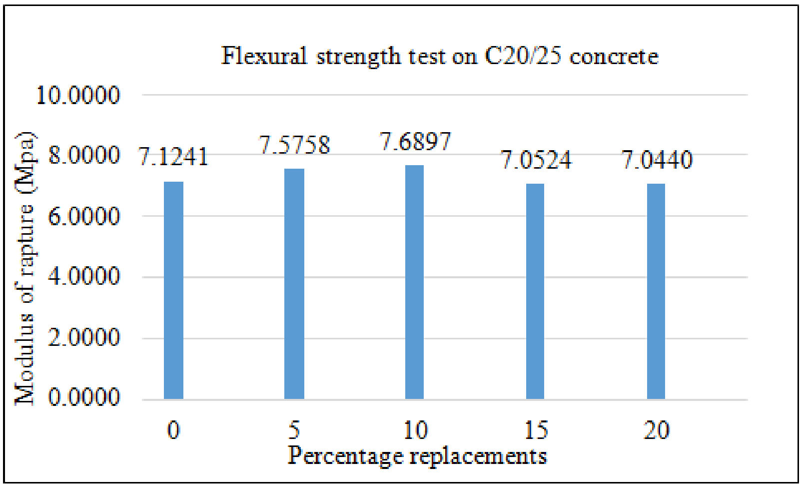

Figure 3: The results of the flexural strength test on concrete mix C20/25

C55/67 as HSC

At the 28-day mark, HSC beams were subjected to a flexural strength test. According to the findings of the tests, the flexural strength was improved by up to 10% by replacing some of the cement with granite powder. When compared to the control beams, the flexural strength increased by 6.24% when only 5% of the material was replaced, while the strength increased by 4.90% when only 10% of the material was replaced. The percentage of replacement that was 15 and 20 decreased the strength by 1.32% and 10.52%, respectively. Therefore, the maximum flexural strength was achieved at 5% replacement, but the strength was still greater than the control strength up to 10% replacement.

CONCLUSION

This research was intended to study the mechanical properties of concrete made by partially replacing cement with granite powder. Granite powder was replaced at 0%, 5%, 10%, 15% and 20% by volume of cement. Then fresh and hardened property of concrete were investigated. Fresh properties of concrete using slump test and hardened properties of concrete were done through strength and durability tests. Compressive strength test and flexural test were performed to evaluate the strength properties. Water absorption test, Sorptivity test, chloride and sulphate attack tests were performed to evaluate the durability properties. These tests were performed on C20/25 grade concrete as normal strength and C55/67 grade concrete as high strength with and without granite powder, then properties were compared and analyzed. The results obtained from the experiment showed reliable data points or facts and promising further research horizon.

REFERENCES

1. Akbulut, H., Cahit, G., 2007. Use of aggregates produced from marble quarry waste in asphalt pavements. Build. Environ. 42, 1921–1930.
2. Binici, H., 2007. Effect of crushed ceramic and basaltic pumice as fine aggregates on concrete mortars properties. Constr. Build. Mater. 21, 1191–1197.
3. Binici, H., Kaplan, H., Yılmaz, S., 2007. Influence of marble and limestone dusts as additives on some mechanical properties of concrete. Sci. Res. Essay 9, 372–379.
4. Cetin, A., 1997. Assessment of industrial wastes in asphalt concrete pavement mixtures. M.Sc. Thesis. Department of Civil Engineering, Natural Science Institute, Anadolu University, Eskisehir, p. 266 (in Turkish).
5. Chindaprasirt, P., Chotithanorm, C., Cao, H.T., Sirivivatnanon, V., 2007. Influence of fly ash fineness on the chloride penetration of concrete. Constr. Build. Mater. 21, 356–361.
6. Jepsen, M.T., Mathiesen, D., Petersen, C., Bager, D., 2001.
7. Durability of resource saving “Green” type of concrete. In: Proceedings of the FIB-Symposium on Concrete and Environment, Berlin, pp. 257–265.
8. Meck, E., Sirivivatnanon, V., 2003. Field indicator of chloride penetration depth. Cem. Concr. Res. 33, 1113–1117.
9. OECD, 1997. Road Transport Research: Recycling Strategies for Road Works. Organization for Economic Co-operation and Development (OECD), Paris, France, pp. 140–148.
10. Otsuki, N., Nagataki, S., Nakashita, K., 1993. Evaluation of AgNO3 solution spray method for measurement of chloride penetration into hardened cementitious matrix materials. Constr. Build. Mater. 7, 195–201.
11. Saboya, F., Xavier, G.C., Alexandre, J., 2007. The use of the powder marble by-product to enhance the properties of brick ceramic. Constr. Build. Mater. 21, 1950–1960.
12. Senthamarai, R.M., Devadas, M.P., 2005. Concrete with ceramic waste aggregate. Cem. Concr. Compos. 27, 910–913.

 RAJA SHAKYA[1]*: *Scholar, Civil department, Madav Institute of technology and science Gwalior. India.*