

An Experimental Study on Partial Replacement of Cement with Granite Powder

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ABSTRACT: The main objective of Waste Management System is to maximize economic benefits and at the same time to protect the environment. Granite process industry generates a large amount of wastes mainly in the form of powder during sawing and polishing processes, which pollute and damage the environment. This work aims to characterize and evaluate the possibilities of using the granite sawing wastes, generated by the process industries as alternative raw materials in the production of concrete. This granite powder waste can be utilized for the preparation of concrete as partial replacement of cement. In order to explore the possibility of utilizing the granite powder as partial replacement to cement, an experimental investigation has been carried out. The percentages of granite powder added to replace cement by weight were 25,50,75. This attempt has been done due to the hike in the price of cement and its limited availability. The Material used for concrete is tested for Quality. The compressive strength of concrete at 28th day is tested. The Design mix is calculated as per IS:10262-2009 concrete mix proportioning and IS:456-2000 – code of practice for plain and reinforced concrete. The Values required for design mix is calculated accurately by testing the material as per IS-Code. The test results were obtained on the basis of compressive strength. It is concluded that concrete with 25%,50%,75% replacement of granite powder possesses great strength and since granite powder considered here are recycled materials, this usage is not only beneficial stability.

KEYWORDS: Granite powder, paver block, compression strength, cost analysis.

I. INTRODUCTION

Concrete is the single most widely used construction material in the world today. It is used in buildings, bridges, sidewalks, highway pavements, house construction, dams, and many other applications. The key to a strong and durable concrete are the mix proportions between the various components. Less cement paste can lead to more voids, thus less strength and durability while more cement paste can lead to more shrinkage and less durability. The gradation and the ratio of fine aggregates to coarse aggregates can affect strength and porosity. The mix design should also achieve the desired workability of concrete so as to prevent segregation and allow for ease of placement. Typically, a concrete mix is about 10% to 15% cement, 25% to 30% sand, 40% to 45% percent aggregate and 15% to 20% water. Entrained air (5% to 7%) is also added to concrete to improve durability. Concrete should have enough compressive strength and flexural strength to support applied loads. At the same time it should have good durability to increase its design life and reduce maintenance costs. In general, durable concrete will have good resistance to freeze and thaw, abrasion, sulfate reactions, ultraviolet radiation, seawater, alkali-silica reaction, and chlorides. The gradation and maximum size of aggregates are important parameters in any concrete mix. They affect relative proportions in mix, workability, economy, porosity and shrinkage of concrete. Granite powder, a waste material from the granite polishing industry, is a promising material for use in concrete similar to those of pozzolanic materials such as silica fume, fly ash, slag, and others. These products can be used as a filler material (substituting sand) to reduce the void content in concrete. Granite powder is an industrial byproduct obtained from crushing of granite stone and granite stone polishing industry in a powder form. It is also generated from recycling marble tops, terrazzo, granite pavers, and stone scraps and discards. If left on its own and is not properly collected and stored, the fine granite powder can be easily be airborne and will cause health problems and environmental pollution.

Inhalation of granite powder fine particles is a health hazard and is a cause of lung diseases especially for people living near granite mills. In this present work, granite powder is used as partial replacement of sand in concrete in different percentage and the associated compressive strength, flexural, and splitting tensile strengths of concrete have been evaluated. By doing so, natural resources of sand can be preserved and the health hazards of these industrial wastes are minimized.

II. REQUIREMENT OF CONCRETE

Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements, such as calcium aluminate cements. When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and moulded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone like material that has many uses. Often, additives (such as pozzolans or superplasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material. Most concrete is poured with reinforcing materials (such as rebar) embedded to provide tensile strength, yielding reinforced concrete.

Famous concrete structures include the Hoover Dam, the Panama Canal, and the Roman Pantheon. The earliest large-scale users of concrete technology were the ancient Romans, and concrete was widely used in the Roman Empire. The Colosseum in Rome was built largely of concrete technology, and the concrete dome of the Pantheon is the world's largest unreinforced concrete dome. Today, large concrete structures (for example, dams and multi-storey buildings) are usually made with reinforced concrete. After the Roman Empire collapsed, use of concrete became rare until the technology was redeveloped in the mid-18th century. Today, concrete is the most widely used human-made material (measured by tonnage).

The first requirement for good concrete is a supply of good cement of a type suitable for the work at hand. Next is a supply of satisfactory sand, coarse aggregate, and water; all of which must be carefully weighed and measured. Everything else being equal, the mix with the best graded, strongest, best shaped, and cleanest aggregate will make the strongest and most durable concrete.

The best designed, best graded, and highest quality mix in the world will not make good concrete if it is not workable enough to fill the form spaces thoroughly. On the other hand, too much fluidity will result in certain defects. Improper handling during the whole concrete-making process (from the initial aggregate handling to the final placement of the mix) will cause segregation of aggregate particles by sizes, resulting in non-uniform, poor concrete. Finally, the best designed, best graded, highest quality, and best placed mix in the world will not produce good concrete if it is not properly cured—meaning, properly protected against loss of moisture during the earlier stages of setting. As you can see, the important properties of concrete are its strength, durability, and water-tightness. These factors are controlled by the water-cement ratio or the proportion of water to cement in the mix.

III. LITERATURE REVIEW

1. K. Shyam Prakash and Ch. Hanumantha Rao, et. al, results of experimental investigations conducted, it is concluded that the quarry dust can be used as a replacement for fine aggregate. It is found that 40% replacement of fine aggregate by quarry dust gives maximum result in strength than normal concrete and then decreases from 50%. The compressive strength is quantified for varying percentage and grades of concrete by replacement of sand with quarry dust.
2. Ravindra Nagar, Vinay Agrawal, Aditya Rana, Anshuman Tiwari, et. al, study investigates the feasibility of using granite cutting waste (GCW) as a partial substitute of river sand in high strength concrete based on strength, durability & micro structural attributes at 0.30, 0.35 and 0.40 water cement ratios (w/c) by substituting 0%, 10%, 25%, 40%, 55% and 70% river sand by GCW suggested that 25–40% river sand can be substituted by the GCW with a favourable influence on the investigated parameters. The optimum amount of GCW to be used in concrete depends significantly upon water-cement ratio of concrete.
3. Hanifi Binici et al. (2008) investigated the Durability of concrete made with granite and marble as recycled aggregates. The ornamental stone industries in Turkey produce vast amount of by-product rock waste (marble, granite) that could be used in concrete production suitable for construction purposes. This work highlighted the durability of concrete made with granite and marble as coarse aggregates. River sand and ground blast furnace slag (GBFS) were used as fine aggregates. The results were compared with those of conventional concretes. Slump, air content, slump loss and setting time of the fresh concrete were determined. Furthermore, the compressive strength, flexural- and splitting-tensile strength, young's modulus of elasticity, resistance to abrasion, chloride penetration and sulphate resistance were also determined.

IV. MATERIALS USED AND TEST PERFORMANCE

1. CEMENT

The Cement is board sense can be described as a material with adhesive and cohesive properties, which is capable of binding mineral fragment into compact mass. There are several types of available of which Portland cement is most well-known and we use it. The OPC-43 grade cement shall confirm to IS:8112-1989 and the designed strength of 28 days shall be minimum 43 MPa or 430 kg/sqcm. Even though 43 Grade cements early strength is less as compared to that of 53 Grade, with time it will attain the same ultimate strength as that of 53 Gradecement. The specific gravity of cement would be 3.15 which is being used.

2. FINE AGGREGATE

Aggregate which is passed through 4.75 mm IS sieve and retained on 75 micron I.S. sieve is termed as fine aggregate. M-sand is well graded and falls within the limits of grading zone-II sand, grading limits specified in IS 383 code. Code allows 20% fines less than 150 microns for crushed stone sands. M-sand is devoid of clay size fraction and the fraction below 150 microns is about 18%. M-sand conforming IS 383-1970 was used in this project.

3. COARSE AGGREGATE

Aggregate which is retained on IS test sieve no. 4.75 mm is called coarse aggregate. Broken stone is generally used as a coarse aggregate. For thin slabs and walls, maximum size of coarse aggregate should be limited to one-third the thickness of concrete section As per I.S. 383-1963, shape of particle of the aggregate may be rounded, regular, angular and flaky. Rounded particles do not have good interlocking, where as irregular and angular particle show very good interlocking effect. Aggregate should have rough surface to get better bond between particles and cement paste. Porosity and water absorption should be less. Use of the largest permissible maximum size of coarse aggregate permits a reduction in cement and water requirements.

4. WATER

Portable waters are generally considered satisfactory for mixing and curing of concrete. The value of pH should not be less than 6. It should not contain high concentration of sodium and potassium. Less than 8% of silt is permissible

5. GRANITE POWDER

Granite powder, a waste material from the granite polishing industry, is a promising material for use in concrete similar to those of pozzolanic materials such as silica fume, fly ash, slag, and others. These products can be used as a filler material (substituting sand) to reduce the void content in concrete. Granite is the plutonic igneous rock because it is formed due to solidification of magma at great depths. The word "granite" comes from the Latin granum. It is a holocrystalline and leucocratic rock because it is completely crystalline and light coloured rock. It is acidic rock because it is very rich in silica content (nearly 72%). Granite is compact, dense, massive and hard rock.

6. COMPRESSIVE STRENGTH TEST

The brick specimens are immersed in water for 24 hours. The specimen is placed in compression testing machine with 6 mm plywood on top and bottom of it to get uniform load on the specimen. The load is applied axially at a rate of 14 N/mm². The crushing load is noted. Then the crushing strength is the ratio of crushing load to the area of block loaded. Average of three specimens is taken as the crushing strength. The crushing load is noted for blocks named 1,2,3,4,5,6&7 (different proportions). For 25% of granite powder, the compressive strength is 2690.05 N/mm². For 50% of granite powder, the compressive strength is 1648.33 N/mm². For 75% of granite powder, the compressive strength is 598.82 N/mm².

7. WATER ABSORPTION TEST

A brick is taken and it is weighed dry. It is then immersed in water for 24 hours. It is weighed again and the difference in weight indicates the amount of water absorbed by the block. It should not exceed 20 percent of weight of dry block. The water absorption of coarse aggregate is 0.5 %.

8. SHAPE AND SIZE TEST

In this test, a block is closely inspected. It should be of standard size and its shape should be truly rectangular with sharp edges. For this purpose, 3 blocks are selected at random and they are stacked length wise, along the width and along the height. In 4.75 mm sieve, the % retained is 99.5 and % passing is 0.5.

9. IMPACT TEST

In this test, few blocks are dropped from 1m height. If blocks are broken it indicates low impact value and not acceptable for construction work. Good quality blocks do not break at all.

10. SOUNDNESS TEST

In this test, two randomly blocks are hardly punched with each other. If they produce a clear metallic sound and remain unbroken then they are good quality blocks.

11. HARDNESS TEST

In this test, scratches are made on the surface of block by a one-rupee coin. If it does not leave any impression the block surface then it will be considered as good quality blocks.

12. EFFLORESCENCE TEST

This test is carried out to obtain the presence of alkaline substances in blocks. After this test procedure, a white or grey layer is formed on block surface, it means alkali is present in the blocks. Fig 1 shows the paver block making process and experimental results.



Fig 1 Granite Powder



Fig 2 Mould for Paver blocks

V. CONCLUSION

The Quality of material used for Granite Powder concrete tested and verified on the basis of IS Code. The specific gravity value of cement, Granite Powder, M-Sand and coarse aggregate required for design mix are tested. All the mixes used for the study shows adequate workability. Workability of concrete satisfied on the basis of site condition for compaction. The Compressive strength of concrete while replacing the Fine aggregate with Granite Powder is tested at 28th day and verified. Due to addition of Granite powder and partial same chemical composition of cement, Compressive strength value obtained is greater than the Conventional Concrete. The Granite powder Concrete of grade M30 is tested as per IS code. Hence huge dumping of waste in the environment is reduced and this may increase the usage of Granite Powder more. Economical construction is also achieved.

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