



Experimental Study on Strength and Durability of Concrete with Partial Replacement of Cement with Granite Slurry and Aggregates with Quartz Stone

Shyamala Bhoomesh¹ and Kashireddi Shivani^{2*}

¹Assistant Professor, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India.

²PG Scholar, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India.

Received: 08 Nov 2022

Revised: 01 Dec 2022

Accepted: 29 Dec 2022

*Address for Correspondence

Kashireddi Shivani

PG Scholar,

Department of Civil Engineering,

Malla Reddy Engineering College,

Hyderabad, Telangana, India.

Email: shivanik.mrec@gmail.com



This is an Open Access Journal / article distributed under the terms of the **Creative Commons Attribution License** (CC BY-NC-ND 3.0) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. All rights reserved.

ABSTRACT

Durability of concrete is controlled by its capacity to oppose enduring activity, chemical attack, scraped spot, or some other cycle of crumbling, and will hold its unique structure, quality, and serviceability when presented to its current circumstance. Solid concrete is a consequence of appropriate plan, proportioning, placement, completing the process of, testing, review, and relieving. India is second biggest shopper of cement after china. However, these days Cement enterprises produce about 10% of the world's carbon dioxide which influences the climate and cause irregularity in the biological system. The surprising expansion in foundation in India has made Indians the best customers of building materials, where the issue of durability over strength is basic. Huge quantity of granite and quartz stone production leads to the collection of enormous quantity of slurry and quartz. Random disposal of this generated waste degrades the environment in numerous ways. Utilization of this waste may solve the problem of waste generation and also the problem of scarcity of natural resources. An exploratory assessment was attempted in this work to examine the durability of M40 grade concrete using granite slurry as cement and quartz as coarse aggregates. Workability, compressive strength, acid attack, alkaline attack, chloride attack, sulfate attack, Rapid chloride test, and porousness test discoveries of concrete are surveyed for 56 and 84 day cubes separately.

Keywords: Durability, chemical attack, Rice husk ash, compressive strength, Permeability test, Rapid chloride test, acid attack test, chloride attack test.





INTRODUCTION

Background Information

Concrete has been available from here onward, indefinitely quite a while; the Minoan human civilization around 2000 BC is the primary reported utilization of a material in view of concrete. Around 300 BC, during the beginning of the Roman Empire, the Romans found that joining a sandy volcanic slag with lime mortar created a hard water boundary material that we currently know as concrete. The most generally involved sort of bond in current cement is Portland concrete. Portland concrete is fabricated by consolidating calcium carbonate, which might be found in limestone or chalk, with silica, alumina, and iron oxide, which can be found in the ground or shale. Contingent upon the nature of the stones utilized, the two fixes are ground and participated in a dry or wet condition. The blend is then warmed to temperatures as high as 1400 degrees Celsius in a heater, where the two rocks entwine to frame clinker. The clinker is permitted to cool before gypsum is added at a pace of 1-5%. The combination is then finely squashed and sprinkled among Concrete cluster plants. Due to the nearby likeness of the completed concrete to the Portland limestone, the Portland bond is named after it. Concrete is quite possibly the most broadly utilized development material since it very well may be tossed into practically any structure, has fantastic compressive properties, is promptly accessible anyplace, and is regularly more affordable than other development materials like steel or fiber composites. Somewhat, these consider total highlights like sub-atomic gauge course, all out total size, and total structure (trademark or crushed). In any case, in light of the fact that these techniques depend on quantifiable information from a wide scope of concrete blends, the outcomes are totaled up, and a particular kind of total, for example, smasher dust or produced totals, is probably not going to convey the normal last Concrete characteristics. Besides, concrete compressive quality evaluations depend on the w/e extent, which might be exact for conventional totals yet might be wrong for outstandingly exact or fine particles. In consistency assessments, comparable impacts might be noticed.

General

In Concrete, the replacement of cement with a certain type of wood powder makes the construction lighter in weight. This article delves into the quality and functionality tests. Compressive strength is one of the most important qualities of cement. Furthermore, increasing the amount of wood residue in the organization resulted in lower unit weights and compressive quality estimates for mortars, as well as an increase in water retention esteems at all ages. The features and benefits in the genuine generation of cement are provided by the hardwood powder dust that is superseded by cement.

Cement and Environment

Concrete is a famous creation fabric because of its excessive quality, solidity, and simplicity of blending and setting. The pinnacle 3 bond-developing international locations are China, India, and the United States. In 2015, China brought 2350 million metric tonnes of concrete, observed through India with 270 million metric tonnes. (www.statista.com). Bond hobby is at the upward thrust globally, and it's far anticipated to upward thrust through 4.5 percentage over the subsequent 5 years. The worldwide call for for concrete is anticipated to attain 5190 million metric tonnes in 2019. Concrete is crafted from a limestone and dirt combination that has been warmed the usage of an electric powered or coal-fired heater. In addition, the manufacturing of bonds creates carbon dioxide, that's one of the most important greenhouse gases that contributes to worldwide warming. It is envisioned that 1 tonne of bond produced releases about 1 tonne of CO₂ into the atmosphere (Davidovits, 1996). The bond enterprise is accountable for 6% of overall CO₂ emissions (www.epa.gov). As humanity faces the wrath of nature within side the shape of massive, inexplicable herbal disasters, it's far essential to keep our surroundings clean. Because bond manufacturing depletes herbal resources, vitality, and leaves a carbon footprint at the planet, it's far essential to locate an opportunity to concrete (Scrivener, 2007).



**Granite**

Granite is a coarse-grained, tough igneous rock this is typically composed of quartz, orthoclase or microcline, and mica. Since historical times, granite has been utilized as a creation fabric. It is one of the maximum historical and long-lasting constructing substances accessible, and it'll outlive the shape wherein it's miles put. Because of its undying splendor and the reality that no artificial fabric can but healthy its beauty and performance, it has come to be the fabric of preference for ultra-modern luxurious homes and businesses. Granite is a not unusual place countertop fabric in kitchens and bathrooms. Granite tiles with a thickness of 20 to 50 mm are usually utilized as counter tops, cashier desks, shelving, benches, and tables. These surfaces are regularly known as granite, however they may be made of loads of stone kinds, which include granite and marble.

Properties of Granite Slurry Concrete

Exploratory examination on the proficient utilization of rock slurry waste might be found in the writing. The utilization of extra stone slurry was accounted for in these preliminaries as changing degrees of F.A. furthermore, concrete replacement. Besides, it has been exhibited that the utilization of stone slurry squander modifies the attributes of both new (functionality) and restored concrete. The effect has been inspected for mechanical characteristics (compressive strength, split elastic, and so forth) and solidness boundaries in solidified concrete (water penetrability, quick chlorine infiltration, and so on). In this way, a basic assessment of the current writing on new substantial characteristics (usefulness), mechanical properties, and strength properties has been audited.

Quartz stone

Quartz is a widely administered mineral this is typically made out of silica, or silicon dioxide (SiO₂). Lithium, sodium, potassium, and titanium are instances of fledgling contaminations. Water-clean gems have been perceived to the memorable Greeks as krystallos, so the expression precious stone, or more prominent oftentimes rock gem, completed to this structure. Quartz is an antique German time-frame of obscure provenance that turned out to be first used in 1530 through method of method for Georgius Agricola. Quartz has a huge industrial value. Amethyst, citrine, smokey quartz, and rose quartz are only some examples of gemstones. Sandstone is a not unusual place creation stone this is usually manufactured from quartz. Quartz sand (additionally referred to as silica sand) is extensively used with inside the manufacturing of glass and ceramics, in addition to for foundry moulds in metallic casting. Sandpaper consists of beaten quartz as an abrasive, silica sand is utilized in sandblasting, and whole sandstone continues to be utilised to fabricate whetstones, millstones, and grindstones. In optics, silica glass (additionally referred to as fused quartz) is used to transmit ultraviolet light. Fused quartz tubing and bins are utilised in a whole lot of clinical applications, and quartz fibres are utilized in ultra-touchy weighing systems. After feldspar, quartz is the second one greatest common mineral with inside the Earth's hull. Practically all corrosive volcanic, transformative, and sedimentary rocks consolidate it. In silica well off felsic rocks like stones, granodiorites, and Rhyolites, it's far a significant mineral. It has a phenomenal protection from enduring and is found typically in sandstones and different detrital rocks.

Objectives And Scope of Investigation

Because of the following factors, concrete has become a prominent building material in all disciplines of modern construction.

1. Using suitable gradients and unique processing techniques, such as mechanical, chemical, and physical, it is feasible to regulate the characteristics of cement concrete across a large range. It is possible to totally automate the process of preparation and placement. It has sufficient plasticity for mechanical work.
2. It's tough to think of another construction material that is as adaptable as concrete. When strength, durability, permanence, permeability, and fire resistance are necessary, concrete is by far the best material to use.
3. In today's world, inflation is one of the most serious issues that any country must deal with. It has become critical to reduce building costs while maintaining structural strength and longevity.
4. Cost reduction may be accomplished in a variety of ways. The utilisation of waste material as a replacement is the



**Shyamala Bhoomesh and Kashireddi Shivani**

most efficient of all the options accessible to us. Shelter is a basic necessity of all humans.

5. The expanding interest for delivering sturdy materials is the result of quick dirtying climate. Beneficial cementitious materials end up being successful to meet the vast majority of the necessities of the tough concrete. Granite slurry and quartz dust are observed to be more noteworthy to other valuable materials like, silica fume and fly debris.
6. To produce concrete of specified qualities from materials of varied characteristics, extensive understanding of the interaction of numerous elements that go into the formation of concrete is necessary, both in the pliable and harden conditions. The strength of concrete is determined by factors such as aggregate, cement quality, water-cement ratio, workability, mix percentage consistency, and concrete age. New building materials are used to accelerate the construction work, in which the mixture plays an important role in characteristics of concrete. The growth in various types of industries together with population growth has resulted in enormous increase in the production of various types of industrial waste materials such as rice husk ash, foundry sand, blast furnace slag, fly ash, steel slag, scrap tires, waste plastic, broken glass, etc

MATERIALS AND METHODOLOGY

Materials Used

Cement

Portland cement is produced using calcareous substances which incorporate limestone and chalk. notwithstanding argillaceous minerals which incorporate shale and earth. Wet and dry cycles are the 2 sorts of cycles. The best variation is if the uncooked substances are blended and floor soggy or dry. Lime, silica, alumina, and iron oxide are the most extreme well known fundamental added substances utilized in cement fabricate. These oxides gather with inside the heater at unreasonable temperatures, resulting in more prominent convoluted blends. The compound linkages that emerge among cement and water are noted as "hydration of cement." Cement hydration might be dealt with in manners. The first is a reaction instrument, wherein cement breaks down to make a totally lowered affiliation wherein hydrated organic entities can create. Second, water falls apart cement compounds over the long run, beginning the floor and progressing into the design. Cement and water take part in an exothermic way. Warmth is gotten because of the reaction. "Warmth of hydration" is the time span for this sort of warm temperature release as shown in table 1. In this examination Ordinary Portland concrete of 53 grade (ACC concrete) has been acquired and has been utilized.

Aggregates

Aggregates are an important part of concrete. They offer a strong base for concrete, decrease shrinkage, and save money. Aggregates are non-essential granular elements that are provided by themselves, such as sand, rock, or crushed stone. They're also the raw ingredients that go into making concrete. Clean, hard, and solid aggregates should be devoid of absorbed synthetic chemicals, dirt, and other small particles that might cause cement to disintegrate.

Coarse Aggregates

Coarse aggregates are debris with a width extra than 4.75mm however a steady variety of 9.5mm to 37.5mm. They can be created out of a huge variety of substances which can be essential, auxiliary, or reused. Essential or virgin aggregates may be located on land or with inside the ocean. Rock is a coarse, land-gained general produced via way of means of the ocean. Rock and beaten stone are examples of course aggregate. Rock makes up the bulk of the course fabric in concrete, with beaten stone accounting for the rest.



**Shyamala Bhoomesh and Kashireddi Shivani****Fine Aggregates**

Sands from both the land and the ocean are used to make pleasant mixture. The maximum not unusual place pleasant aggregates are herbal sand or beaten stone, with the bulk of debris passing thru a 4.75mm screen.

The pleasant mixture on this observe became river sand, which become received from a nearby producer and illustrated within side the figure.

Water

Water is an critical issue of cement as it performs a position within side the compound response 35 of concrete and water. Because it advances the layout of the strength-giving concrete gel, the quantity and sort of water have to be cautiously studied. C3S calls for 24% water through weight. while C2S necessitates 21%. A produced response the use of Portland concrete mixes has additionally been determined to want on common 23 percentage water through weight of concrete. Because it's far purposely bonded to solidify, this 23 percentage of water is known as bound water. It's additionally been calculated that kind of 15% of the burden of the concrete could be used to fill the gel-pores. For the whole chemical response and to burn-thru the vicinity inner gel-pores, a flat out 38 percentage of water through weight of concrete is necessary. We have to study the perfection and nature of water in view that they've an effect on strength. When figuring out if water is appropriate for blending concrete, the guideline of thumb of thumb is if it's far appropriate for drinking. Manganese, tin, zine, copper, and lead salts all degrade cement's strength. A turbidity restriction of 2000 segments in keeping with million has been counseled as a very good beginning point. This experimental programme hired regionally available consumable new water that become freed from centralizations of aid and normal materials for mixing and reestablishing.

Granite Slurry

Granite's hardness and durability, in addition to its ubiquitous availability, have made it a family call for utilization as a constructing stone all around the world. Granite is ample in India, and in spite of its recognition as a miner's material, it's far a huge supply of forex revenue. After China. India is the second one biggest provider of uncooked granite, after handiest Brazil and South Africa. Granite mines in India are disbursed throughout the country, with Karnataka (25%) main 15 the way, accompanied via way of means of Jharkhand (24%), Rajasthan (23%). Andhra Pradesh (69%), Madhya Pradesh (five), and Orissa (4%). (five percent). Karnataka's granite zone contributes a massive part of countrywide and global output, accounting for round 20% of the worldwide market.

Quartz Stone

Granite and other felsic igneous rocks have quartz as a distinguishing element. Sandstone and shale are examples of sedimentary rocks where it is quite frequent. Schist, gneiss, quartzite, and other metamorphic rocks all contain this mineral. Because quartz has the lowest weathering potential of the Goldich dissolution family, it is abundant as a residual mineral in stream sediments and residual soils. Quartz is commonly found in abundance in "mature" rocks. indicating that the rock has been severely reworked and that quartz was the dominant material that withstood severe weathering. Quartz crystallises from molten magma in the majority of cases, although it also chemically precipitates as gangue in hot hydrothermal veins, occasionally alongside ore minerals like gold, silver, and copper. In magmatic pegmatites, large quartz crystals can be found. Crystals that are well-formed can grow to be several metres long and weigh hundreds of kilos. Quartz crystals of exceptionally high purity, which are required for the crucibles and other equipment used in the semiconductor industry to create silicon wafers, are expensive and scarce.

Methodology Used**Slump Cone Test**

The droop cone take a look at is used to estimate a function of latest concrete. The test is designed to decide how nicely new concrete performs. It assesses consistency among bunches in a extra distinct manner. The take a look at is famous due to the device's simplicity and easy methodology.

1. A cone frustum with a peak of three hundred mm is used for the hunch take a look at (12 in). The base is about 2 hundred mm (8in) lengthy with a one hundred mm hole at its finest factor.



**Shyamala Bhoomesh and Kashireddi Shivani**

2. The shape is placed on a stage floor, and the compartment is full of 3 layers of concrete, so as to be evaluated for usability.
3. Each layer is heated usually over a sixteen mm (five/eight in) metal rod, with the gap among layers changing because the manner advances.
4. After the shape has been totally loaded with concrete, the finishing floor is struck off (leveled out with the shape zenith opening) utilizing screening and temping shaft advancement.
5. During the action, the shape should be safely gotten towards its base all together that it truly does now never again stream in light of the pouring of cement, which might be accomplished with the guide of utilizing methods along with holds or stools brazed to the shape.
6. Once the filling is whole and the concrete is leveled out, the cone is reasonably and as it thought to be driven higher, an unsupported durable will currently get a handle on. Slump relates to the suspended concrete's factor of convergence's diminution in peak. The grasp is calculated with the aid of using setting the cone close to to the placing concrete after which positioning the temping submit over the cone in order that it does now no longer contact the hung concrete.
7. Scale suggests the lower in cement's stature in comparison to that of the construction. (Most measurements are taken to the nearest five mm (1/four in).)

Compressive strength test

The following ideas have been accompanied while developing this test: ([9] IS516-1959). The compressive strength of concrete changed into examined the use of widespread 150x150x150mm cubes. On a CTM bearing floor with a restriction of 200T and a regular charge of stacking connected. The compressive quality ([21] AS Alumium) changed into calculated after the very best intense load changed into observed.

Durability of concrete

The toughness of M40 grade still up in the air with various level of rock slurry and quartz stone. Strength concentrates on for the most part Acid assault test, Sulfate assault test, Alkaline assault test, Chloride assault test and Rapid Chloride Permeability Test.

MIX DESIGN OF CONCRETE

In this study, mix proportion for M40 grade concrete is done utilizing the IS technique.

RESULTS ANALYSIS

Workability of Concrete:

Slump Cone Test

Compressive Strength of Concrete

Durability of Concrete

Acid attack test

Alkaline attack test

Chloride attack test

Sulphate attack test

Durability of Concrete

CONCLUSIONS

The motivation behind this examination is to explore the strength and durability of concrete using fluctuating rates of granite slurry and quartz stone in M40 grade concrete, going from 0% to 25% and 0% to 50%. The accompanying discoveries were drawn from this exploration.





Shyamala Bhoomesh and Kashireddi Shivani

1. For M40 grade concrete, the slump cone test esteems increment when the extent of granite slurry and quartz stone from 0% to 25% and 0% to 50%
2. The 10%GS+20%QS case yielded the most elevated compressive strength for the M40 grade following 7 days and 28 days of relieving, contrasted with different blends.
3. To keep up the ideal workability, the measurement of super plasticizer must be brought up pair with the GS fineness because of the GS high ingestion quality.
4. For M40 grade concrete blend, the rate loss of compressive strength for corrosive, basic, sulfate, chloride, and alkalinity arrangement increments as the extent of granite slurry and quartz stone from 0% to 25% and 0% to 50%
5. The quick chloride porousness test is performed with fluctuating groupings of granite slurry and quartz stone from 0% to 25% and 0% to 50%. As the extent of rice husk ash is expanded, the RCPT esteem brings down.
6. As the measure of rice husk ash in the water penetrability rises, the profundity of entrance for the M40 grade increments.

REFERENCES

1. Almeida N, Branco F, Santos JR. Recycling of stone slurry in industrial activities: Application to concrete mixtures. *Building and Environment*. 2007 Feb; 42(2):810–9. <https://doi.org/10.1016/j.buildenv.2005.09.018>
2. Hudson BP. Manufactured sand for concrete: Talks of the many properties that good manufactured sand can offer to enhance the performance of concrete. *Indian Concrete Journal*. 1997; 71:237–41.
3. Safiuddin M, Raman SN, Zain MF. Utilization of quarry waste fine aggregate in concrete mixtures. *Journal of Applied Sciences Research*. 2007; 3(3):202–8.
4. World Business Council for Sustainable Development (WBCSD)/International Energy Agency (IEA). *Cement Technology Roadmap 2009- Carbon emissions reductions up to 2050*. 2009. Available from: www.iea.org/papers/2009/Cement_Roadmap.pdf.
5. World Business Council for Sustainable Development (WBCSD)/International Energy Agency (IEA). *Cement roadmap targets; 2009b*. Available from: www.iea.org/papers/2009/Cement_Roadmap_targets_viewingPdf
6. Rego G, Martínez C, Quero A, Blanco TP, Borquea JM. The effects of dust inhalation in slate industry workers. *Medicina Clinica*. 2001 Mar; 116(8):290–1. [https://doi.org/10.1016/S0025-7753\(01\)71802-7](https://doi.org/10.1016/S0025-7753(01)71802-7).
7. Barbosa MS, Carneiro AP, Maciel JG, Moronte EA, La Rocca PD, Santos ARM. Silicosis among quartzite production workers of São Thomé das Letras-Minas Gerais region: Initial data indicate serious public health issue. *Revista Brasileira de Saúde Ocupacional*. 2011 Jun; 36(123):177– 84. <https://doi.org/10.1590/S0303-76572011000100018>.
8. Menezes RR, Neves GA, Ferreira HC, Santana LNL. Recycling of mine wastes as ceramic raw materials: An alternative to avoid environmental contamination. INTECH Open Access Publisher; 2012.
9. Pappu A, Saxena M, Asolekar SR. Solid wastes generation in India and their recycling potential in building materials. *Building and Environment*. 2007 Jun; 42(6):2311–20. <https://doi.org/10.1016/j.buildenv.2006.04.015>.
10. Ribeiroa SV, Holandaa JNF. Soil-cement bricks incorporated with granite cutting sludge. *IJESIT*. 2014 Mar; 3(2).
11. Ramos T, Matos AM, Schmidt B, Rio J, Sousa-Coutinho J. Granitic quarry sludge waste in mortar: Effect on strength and durability. *Construction and Building Materials*. 2013 Oct; 47:1001–9. <https://doi.org/10.1016/j.conbuildmat.2013.05.098>.

Table 1: Constituents of Cement

Constituents	Percentage	Averages
Lime (CaO)	60 to 70%	63
Silica (SiO ₂)	17 to 25%	20
Alumina (Al ₂ O ₃)	3 to 8%	6
Iron oxide (Fe ₂ O ₃)	0.5 to 6%	3
Magnesia (MgO)	0.1 to 4%	2
Sulphur Trioxide (SO ₃)	1 to 3%	1.5
Soda and potash (Na ₂ O + K ₂ O)	0.5 to 1.3%	1





Shyamala Bhoomesh and Kashireddi Shivani

Table 2 : Chemical composition of cement

Physical properties	Test result	Test method/ Remarks	Requirement as per IS 12269 (1987)
Specific gravity	3.15	IS 4031(1988) – part 11	–
Fineness (m ² /Kg)	311.5	Manufacturer data	Min.225 m ² /kg
Normal consistency	30%	IS 4031 (1988)- part 4	–
Initial setting time (min)	90	IS 4031 (1988)- part 5	Min. 30 min
Final setting time (min)	220	IS 4031 (1988)- part 5	Max. 600 min
Soundness			
Lechatelier Expansion (mm)	0.8	Manufacturer data	Max. 10 mm
Autoclave Expansion (%)	0.01		Max. 0.8%
Compressive strength (MPa)			
3 days	25	IS 4031 (1988)- part 6	27 MPa
7 days	39		37 MPa
28 days	57		53 MPa

Table 3: Final trial mix for M40 grade concrete

MATERIAL	CEMENT	FINE AGGREGATES	COARSE AGGREGATES	WATER
Density	438 kg/m ³	717.12 kg/m ³	1115 kg/m ³	197 kg/m ³
Proportions	1	1.63	2.54	0.45





Shyamala Bhoomesh and Kashireddi Shivani



Fig 5 : Quartz Stone

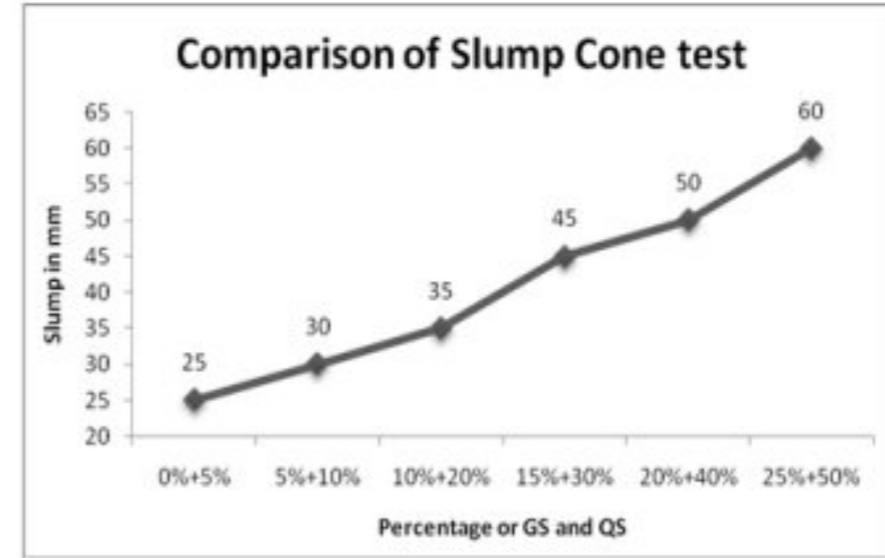


Fig 6: Slump Cone Test

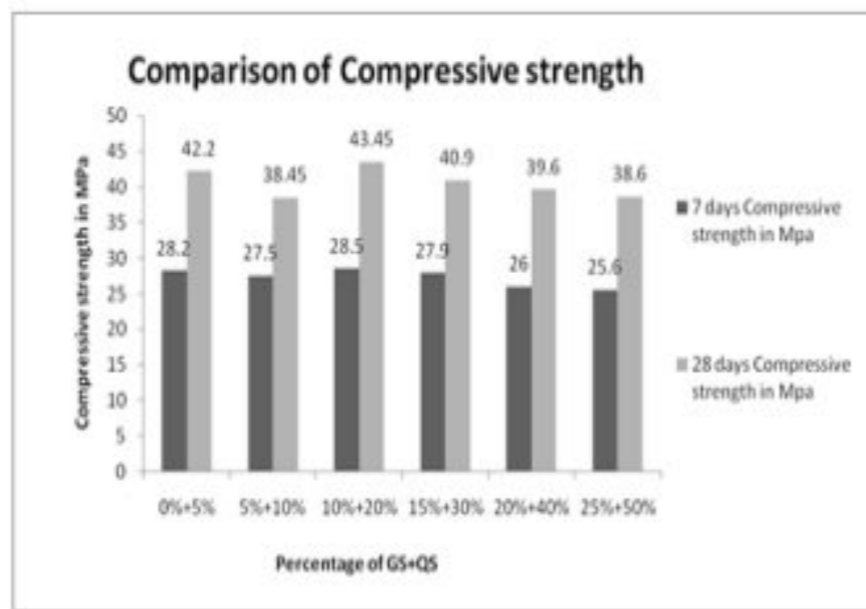


Fig 7: Compressive Strength of Concrete

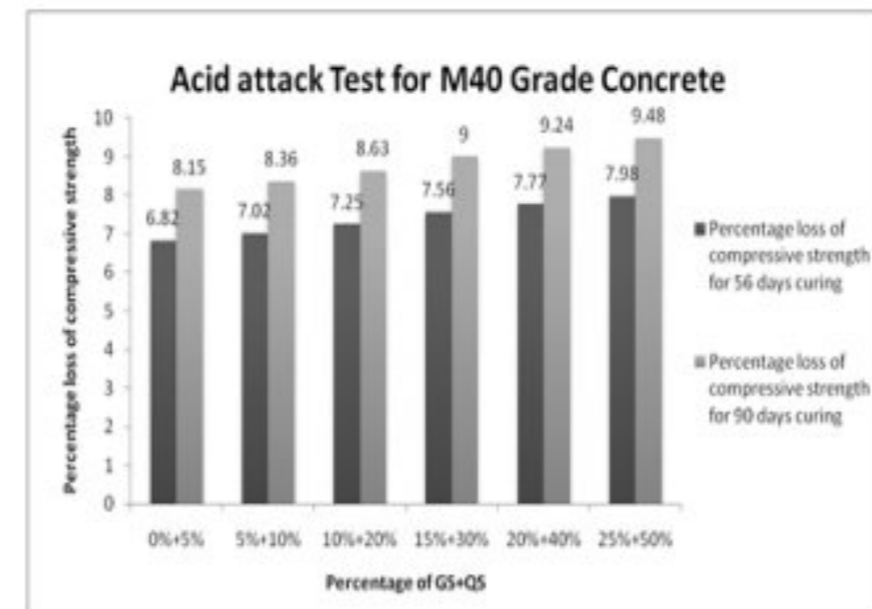


Fig 8: Acid attack test

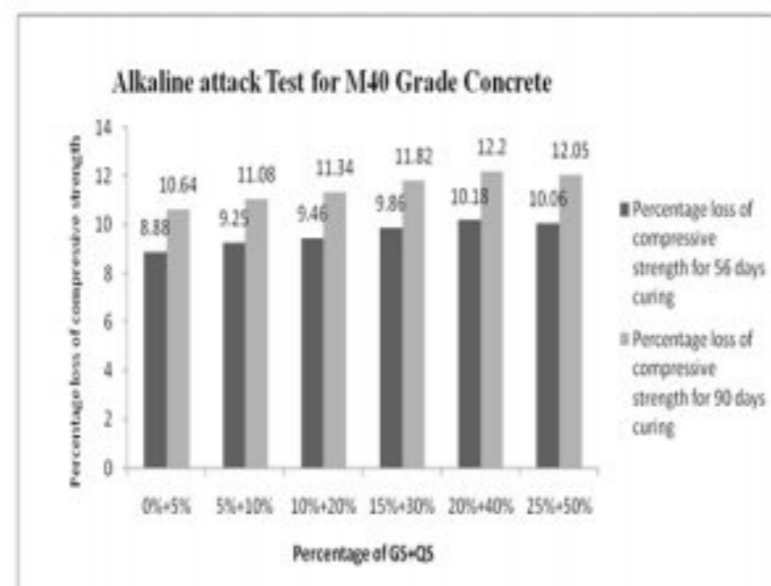


Fig 9: Alkaline attack test

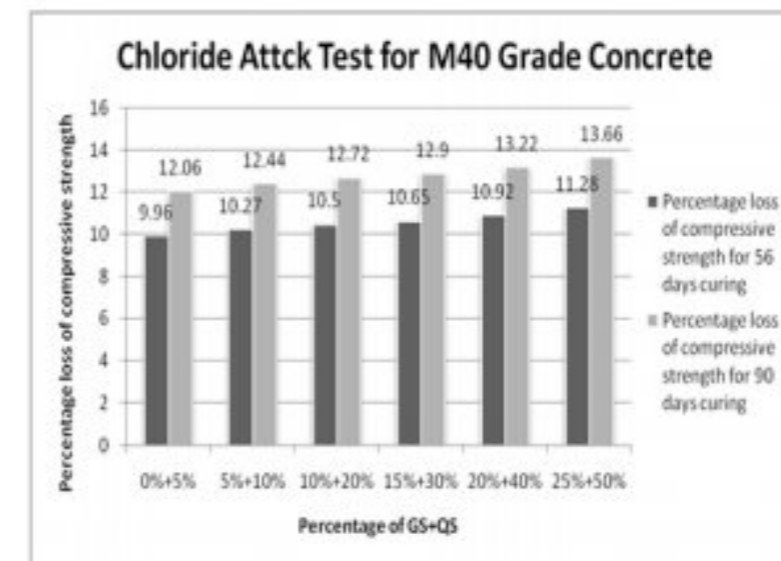


Fig 10: Chloride attack test

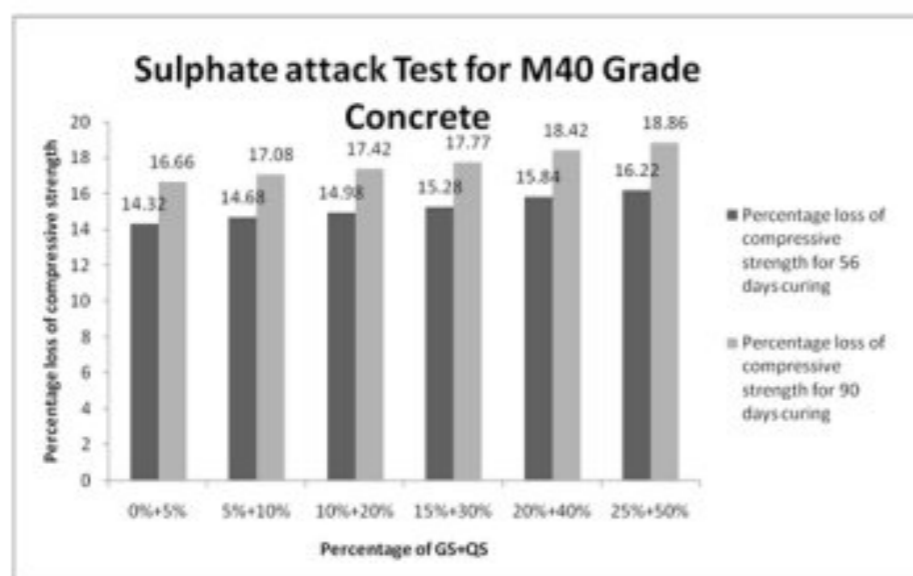


Fig 11 : Sulphate attack test

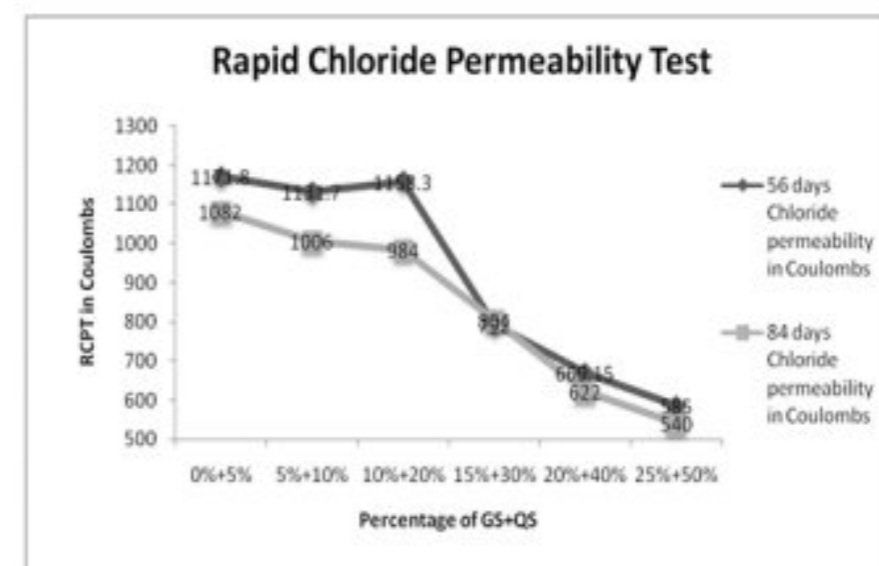


Fig 12: Durability of Concrete

