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A STUDY ON SMART HIGHWAY TRAFFIC MANAGEMENT USING INTELLIGENT TRANSPORTATION SYSTEM

Mamta Kumari[*1], **Nikhil**[*2]

[*1]M.Tech Student, Department Of Civil Engineering, World College Of Technology And Management, Gurugram, Haryana, India.

[*2]Assistant Professor, Department Of Civil Engineering, World College Of Technology And Management, Gurugram, Haryana, India.

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ABSTRACT

A paver is a paving stone, tile, [6] brick [7] or brick-like piece of concrete commonly used as exterior flooring. They are applied by pouring a standard concrete foundation, spreading sand on top, and then laying the pavers in the desired pattern. No actual adhesive or retaining method is used other than the weight of the paver itself except edging. Pavers can be used to make roads, driveways, patios, walkways and other outdoor platforms.

This study investigates the possible way for constructing pavement blocks by using waste. The experiment was conducted with the proper utilization of solid waste in construction of paver blocks without affecting the various mechanical properties such as compressive strength, flexure strength and split tensile strength. The waste which we have g selected the waste generated by quartz stone quarrying or at the time of its dressing. This waste quartz product will be used for replacing the coarse aggregates by some defined percentage and tested. After testing results are concluded and explaining their behavior. The compressive strength was found to be in between 47.35 N/mm2 to 44.98N/mm2. But we observed that up to 40% replacement of coarse aggregate with quartz stone generally does not show any major difference. The replacement of coarse aggregate with the quartz stone generally does not affect the flexural strength of the paver blocks. In the same manner the split tensile strength of the paver blocks does not show any effect by the replacement of coarse aggregate with quartz stones. The approximate value is found to be 46.5N/mm2.

Based on these experiments we concluded that the waste generated by the quartz stone can be used as an alternative for the natural crushed stone used in paver blocks as the compressive Strength, flexural strength and the split tensile strength of the testing blocks does not show any major difference with its original standard mix paver blocks strength. flexural strength and the split tensile strength of the testing blocks does not show any major difference with its original standard mix paver blocks.

Quartz is a silica (silicon dioxide)-based hard, crystalline mineral. SiO2 is the overall chemical formula of silicon dioxide. The atoms are connected in a continuous framework of SiO4 silicon–oxygen tetrahedra, with each oxygen being shared between two tetrahedra. As a result, quartz is categorized as an oxide mineral compositionally and as a framework silicate mineral architecturally. After feldspar, quartz is the second most common mineral in the continental crust of Earth.[10]. There are two types of quartz: the chiral normal α-quartz and the high-temperature β-quartz. The transition temperature of α-quartz to β-quartz is 573 °C (846 K; 1,063 °F), which occurs suddenly. When ceramics or rocks cross this temperature threshold, they are susceptible to micro fracturing due to the considerable volume change that accompanies the transformation.

Quartz comes in a wide range of forms, some of which are categorized as gemstones. Ever since antiquity, quartz variants have been the most widely used minerals, particularly in b Europe and Asia for Jewelry and hardstone carvings. The mineral quartz defines the hardness of a material at 7 on the Mohs scale, which is a qualitative means of assessing a material's resistance to abrasion.

I. INTRODUCTION

1. General:

Transportation engineering or transport engineering is the application of technology and scientific principles to the planning, functional design, operation and management of facilities for any mode of transportation in order to provide for the safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods.

1.1 Importance of Transportation:

The importance of transportation engineering within the civil engineering profession can be judged by the number of divisions that are directly related to transportation. There are six such divisions (Aerospace; Air Transportation; Highway; Pipeline; Waterway, Port, Coastal and Ocean; and Urban Transportation) representing one-third of the total 18 technical divisions within the ASCE.

Following is the importance of Transportation engineering:

a) For the planning aspects of transportation engineering relate to elements of urban planning and involve technical forecasting decisions and political factor.

b) For the technical forecasting of passenger travel usually involves an urban transportation planning model, requiring the estimation of trip generation, trip distribution, mode choice, and route assignment. More sophisticated forecasting can include other aspects of traveler decisions, including auto ownership, trip chaining and the choice of residential or business location. Passenger trips are the focus of transportation engineering because they often represent the peak of demand on any transportation system.

c) Providing highly efficient traffic flow through ample research and innovative design efforts.

d) To produce a free flow of traffic.

e) Use research to design roadways and highways that increase traffic safety (strategic implementation of stop signs, traffic signs, and traffic lights).

f) Transportation engineering refers to a safe, efficient and disciplined way of transport of people and goods. The roots of transportation engineering begin at the stage of urban development and planning.

g) Transport engineering involves the geometric alignment and layout of the width of the number of lanes, pavements, roads, and the thickness. It also devices methods of maintaining lane discipline thus reducing the number of accidents.

1.2 Paver Bricks:

A paver is a paving stone, tile, [6] brick [7] or brick-like piece of concrete commonly used as exterior flooring. In a factory, concrete pavers are made by pouring a mixture of concrete and some type of coloring agent into a mold of some shape and allowing it to set. They are applied by pouring a standard concrete foundation, spreading sand on top, and then laying the pavers in the desired pattern. No actual adhesive or retaining method is used other than the weight of the paver itself except edging. Pavers can be used to make roads, driveways, patios, walkways and other outdoor platforms.

1.2.1. Type of Pavers:

1.2.1.1 Interlocking Concrete Pavers:

An interlocking concrete paver is a type of paver. This special type of paver, also known as a segmental paver, has emerged over the last couple of decades as a very popular alternative to brick, clay or concrete. [8] Segmental pavers have been used for thousands of years. The Romans built roads with them that are still there. But it was not until the mid-1940s that pavers began to be produced out of concrete. It started in the Netherlands [7] where all the roads are made to be flexible because the country is below sea level and the ground shifts, moves and sinks. Poured concrete is not an option because it will crack.

Individual units not set in concrete and placed in sand perform far better than concrete.[7] Before the paver was made from concrete, either real stone or a clay product was used.

The first solid pavers resembled bricks, measuring 4”. The stones, measuring 8 inches by Eight Inches (Twenty cm x Twenty cm), were commonly referred to as Holland Stones. a name they retain today. These units proved cost-effective to manufacture and boasted exceptional durability. Alongside their economic advantages, interlocking concrete pavers come in various water-permeable designs, offering ecological benefits. By facilitating water drainage akin to natural absorption, these pavers aid in mitigating surface runoff and preventing soil erosion or stagnant water accumulation. Certain permeable paver setups even incorporate rainwater harvesting systems, allowing for its reuse in activities like irrigation or car washing.

1.2.1.2. Stone Pavers:

A stone paver represents another option in the realm of paving materials. Widely utilized in both construction and landscaping, this paver is highly esteemed for its aesthetic appeal, robustness, and longevity. Various materials are employed in crafting stone pavers, ranging from limestone and bluestone to basalt (such as the variety sourced. Palisades utilized in New York City." Unlike other stones, travertine is incredibly strong and non-porous, keeping its cool, smooth surface even in bright sunshine. Because of this feature, it's a well-liked option for outdoor entertainment areas, patios, walks, and pool edges. Travertine is prized for its useful qualities since it is well-known for its resistance to salt and low reflection of sunlight. Because of their remarkable density and strength, granite pavers are very durable and low maintenance for outdoor use. Natural limestone blocks that can be found in sedimentary rock formations on the ocean floor and in mountainous areas make up limestone pavers, which have distinct natural color variations. Natural stone is the source of sandstone pavers, which are frequently used for patios, backyards, and walks.

1.2.2. Standards for Paver Bricks:

As per IRC some standards are specific these standards are shown in following table.

1.2.3. Types of Paver Interlocking Blocks:

1.2.3.1. As per INDIAN STANDSRD Specification:

IS 15658:2006 categories the paver blocks into 3 different categories namely:[13]

- CATEGORY A
- CATEGORY B
- CATEGORY C

The various shapes in these categories are shown in figure 1.6

1.2.3.2. On the basis of Different Shapes:

Based on their design these blocks are as follow:[15]

- Brick
- Cross Dumble
- Cube
- Dumble
- Fan
- Grass Paver
- Grass Paver Cross
- Hexagon
- Mirror
- Milano
- Round Dumble
- Square
- Cosmic
- Trihex Groove
- TrihexYellow
- Hexagonal
- Arrowhead

1.3 Quartz:

Quartz is a metamorphic rock made up of recrystallized carbonate minerals, primarily calcite or dolomite. It may exhibit foliation. In geological contexts, "quartz" typically denotes metamorphosed limestone, although in stonemasonry, the term is broader and includes unmetamorphosed limestone. Quartz finds widespread application in sculpture and construction due to its versatility as a building material.

This root also serves as the foundation for the English term "marmoreal," which signifies "resembling quartz." Although the English word shares similarities with the French "quartz," many other European languages adhere to the Greek original.

1.3.1. Physical Origins:

Quartz is formed when sedimentary carbonate rocks, primarily dolomite or limestone, undergo metamorphism. The original carbonate mineral grains undergo modification because of this process, giving rise to a quartz rock with a complicated arrangement of carbonate crystals. During metamorphosis, the original textures, and structures of the carbonate rock, referred to as photolith, typically change or disappear. The transformation of extraordinarily pure (low silicate) limestone or dolomite photolith yields pure white quartz. Mineral impurities such as chert, silt, sand, clay, or iron oxides that were formerly present in the limestone as grains or layers are often responsible for the distinctive patterns found in different colored quartz varieties. Serpentine growth typically results in green tones.

1.3.2 Quartz Waste:

Utilizing quartz waste as a material represents a crucial aspect of environmental management towards achieving sustainable development. However, recycling this waste without robust scientific research and development may lead to environmental challenges surpassing the impact of the waste itself. Waste generated from quarry operations involving quartz can pose risks and harm to the environment. With the escalating costs of materials, incorporating waste material into concrete production can effectively reduce expenses. In India, millions of tons of waste from quartz industries are generated through cutting, polishing, processing, and grinding. Direct exposure of this waste to the environment can trigger environmental issues. Consequently, many countries are actively exploring strategies to repurpose this waste. Materials.

The increase in population, urbanization, and enhanced living conditions has resulted in a surge in the diversity and amount of solid waste stemming from industrial, mining, residential, and agricultural endeavors. In India, around 960 million tons of solid waste are generated, posing considerable environmental and ecological hurdles. Within this framework, a significant industrial byproduct is the quartz residue generated by quartz processing plants. In India, the quartz processing sector produces roughly During the sawing and polishing procedures, the quartz processing industry in India generates over seven million tons of residue, primarily in the form of powder. This residue is frequently disposed of in open areas, leading to environmental contamination and degradation. The state of Rajasthan faces significant pollution concerns due to its extensive quartz mining and cutting operations, with approximately 4000 quartz mines and 1100 quartz cutters spread across 16 districts. Rajasthan alone contributes 95% of India's total waste output, amounting to 6 million tons annually. Key quartz residue-producing regions in Rajasthan include Sikar, Ajmer, Alwar, Sironi, Jaipur, Dungarpur, Bhilwara, Bundi, and Jhunjhunu.

Technology and Action for Rural Advancement (TARA), based in New Delhi, is leading a project to perform pilot studies and showcase its uses in particular parts of Rajasthan in order to examine the potential large-scale exploitation of quartz sludge. The Department of Science and Technology's SEED Division, which is part of the Ministry of Science and Technology of the Government of India, is supporting and facilitating this project.

Several conversations with small- to medium-sized brick manufacturers have highlighted the following requirements to promote the usage of quartz sludge in brick production. The following categories apply to these needs: demonstrating the practicality of incorporating quartz sludge in clay brick production, demonstrating this production of high-quality bricks at a reasonable cost, providing on-site long-term training and capacity-building support for molders, offering Access to affordable credit with favorable interest rates remains essential for economic stability and growth. Accessing funds via formal financial institutions or government subsidies and securing marketing incentives and support for "ECO BRICKS" in Rajasthan's state and federal government agencies."

1.4 Scope of Study:

a) Development of Eco-friendly high strength paver blocks pavement.

b) To solve the problem related to solid waste management of Quartz waste which creates difficulty to dispose

c) To investigate the potential application of these materials in the construction industry.

d) To discover substitutes for natural resources (Coarse Aggregate).

e) The ongoing advancements in the construction industry are driving a growing need for alternatives to traditional concrete materials.

f) The necessity for an environmentally sustainable setting drives the utilization of waste in concrete, preventing the inappropriate disposal of waste materials.

g) Strength of concrete incorporating alternative materials should satisfy the overall requirements.

h) Utilizing quartz waste as an alternative material for concrete aggregate meets the requirements for concrete materials and promotes environmentally friendly waste disposal.

II. METHODOLOGY

In October 2014, Yole, R.C. and Dr. Varma, M.B. carried out an experiment wherein they substituted spherical steel aggregates for traditional aggregates and employed rubber pads at the base for testing. They created a nominal mix by weight with the ratios of cement, aggregate, and water being 1:1.84:2.76, respectively [21]. There were five distinct varieties of paving blocks produced, each having a different amount of aggregate replacement—10%, 20%, 30%, and 40%. Rubber pads that were each 10 mm thick were placed underneath the blocks for the impact test. The average impact value climbed from 4.33 for 0% replacement to 6.33 for 30% replacement when the rubber pad beneath the paving block was removed during testing, according to their findings, as the percentage of steel ball bearings grew. However, after increasing the replacement to 40%, the average impact value decreased to 5 [2]. After the rubber pad was placed at the bottom, impact values increased noticeably; these increases ranged from 500% to 600%. Specifically, the impact test values increased from 23.330 to 350 for 10% and 40% replacements with steel ball bearings, respectively. They discovered that the increased density of the paver block was responsible for the increasing affected values. They also mentioned that using a rubber pad underneath would significantly boost the impact value due to the shock-absorbing properties of the pad. Their experiment yielded various results, as depicted in tables 2.1 and 2.2 below.

In another study conducted by Khandvhe, P.V. and Rathi, A. S replaced coarse aggregate by quartz stone. The percentage of quartz stone was 0%, 17%, 34%, 51%, 65%, 85% and 100% in a nominal mix proportion of 1:2:4. They prepare a total of 21 blocks, 3 blocks of each nominal mix proportion. The Cement content was 2.741 kg, sand was 5.416 and w/c ratio was 0.6 throughout experiment. The various quartz stone waste proportions were shown in table 2.3. They performed water absorption test, compressive strength test and splitting strength test on these 7 types of percentage replacement by quartz stone. Based on their study they concluded that the water absorption percentage slightly increases to 3.81 % from 2.96% for 0 % replacement to 100% [22]. The test results for the compressive strength show a very slightly decrease or almost negligible effect in compressive strength for a replacement of 0% to 100% quartz stone from 47.45 to 47.39 n/mm2 [22]. During the experiment, the splitting test remains unaffected for all other percentage replacement except for 21% replacement by quartz stone. The splitting test result was 41.08 N/mm2 at 51% replacement. Finally, they concluded that by increasing the percentage replacement of aggregate by quartz stone the water absorption gets affected as it increases. The other properties such as compression testing and splitting testing do not show any major or noticeable changes. The results of their experiment named concrete paving block using quartz stone industry waste are shown below in table2.3.

An experiment performed by Patnaik, T. et al (2018) on interlocking concrete paving block (ICPB), replaced cement by fly ash and glass powder and studied its effects on various properties. These paving blocks are manufactured from semi dry mixes under the action of vibration and pressure. They prepared five different M40 grade mixes i.e., having mix proportion of 1:2:3, The concrete mixture was substituted with e amounts of fly ash and glass powder, each varying in % from 0 to 40." 24

Compressive test, flexure test, tensile strength test, abrasion resistance test and water absorption test were performed on above stated mixes at 7, 28 and 56 days. On compressive strength, the mix having 20% fly-ash and 20% glass powder shows maximum strength of 41.41, 51.98 and 52.32 N/mm2 for 7, 28 and 56 days respectively.

On flexural strength, the mix having 20% fly-ash and 20% glass powder shows maximum strength of 3.64, 5.61 and 5.66 N/mm2 for 7, 28 and 56 days respectively [23]. On Tensile Splitting strength, the mix having 20% fly-ash and 20% glass powder shows maximum strength of 3.12, 3.71 and 3.75N/mm2for 7, 28 and 56 days respectively. While the water absorption test and abrasion test show a maximum of 1.68 for 56 days and 2.58% at mix having 40% fly-ash and 40% glass powder. They finally concluded that higher compressive strength flexural strength and tensile splitting strength was achieved when 20% fly-ash and 20% glass powder replace 40% of cement proportion without any major effect on water absorption percentage and abrasion strength. All experiment results are shown in table 2.4[23].

In a distinguished paper having title A research paper on use of waste material in interlocking tiles to improve its quality, Meena, A.K. et al (2016) uses fly ash and crushed steel and studied their effects on various properties. They added this crushed steel in the upper part of the paving tiles only. The percentage of crushed steel were 0%, 2.5%, 5% and 7.5% with a constant addition of 5 % fly ash when we are adding crushed steel. They also studied various properties of crushed steel, fly-ash, cement, coarse and fine aggregates as per standard codes.

The mixed proportion was M30 with a water cement ratio of 0.43. In addition to that they also used 1 % Calcium Lingo Sulphonate super plasticizer for high workability at lower water binder ratio. These interlocking tiles were tested after 7 and 28 days. They only performed the compressive test for these mixes [24]. From their investigation they concluded that 43.1 N/mm2 was the maximum compressive strength which was obtained at replacement level of 7.5% crushed steel and 5 % fly ash after 28days.

Kapata, S.S. and Astone, S. R. performed an experiment by replacing the fine aggregate partially by quarry dust. They adopted a design mix of M25. They replaced 0%, 20%, 25%, 30%, and 35% of natural Sand River. The coarse aggregate taken for this experiment were granite and basalt river stones only. Several physical properties tests were performed by them on quarry dust, fine aggregate, cement and coarse aggregate and the results are shown in Table 2.6.

Additional tests included the split tensile test, flexural strength, workability, and compaction of fresh concrete as well as compressive strength and split tensile testing of hardened concrete. For the test for workability and compaction factor they noticed that at 0.44 water cement ratio 60mm slump value and 0.91 compaction factor founded on M5 (35% quarry dust) on fresh concrete [25]. The results of compressive strength of 53 grade cement was seen higher at 25% was 39.23 MPa for 28 days. Similarly for split tensile strength, a value of 2.65 MPa was achieved at 0% for 28 days, for flexural strength, a value of 5.11 MPa was achieved at 0% for 28 days.

From a general review paper presented by Karthik, M.P. et.al. in 2017, we came to know that due to advancement in industries and technology, there is an advancement in concrete technology too. They also highlighted the different kind of histories shown that this technology or method of covering road was developed in Giza, Egypt before 4500 years or in Holland, Having a conflict but he assured that after World War II, the Europeans were started to reconstruct the roads using these technologies [26].

Anji Reddy et. Al. (2015) found that by replacing 0.3% of fine aggregate by nylon fiber and 20% replacement of cement with rice husk ash, the compressive strength of M35 cube can be increased by nearly 18%. The different percentage of replacement they used were 0.1%, 0.2%, 0.3%, 0.4% and 0.5% for fine aggregate with nylon fiber and 10%, 20% and 30% for cement with rice husk.[27]

Coconut fibers are also used as a replacement of fine aggregates by G. Naya and J. Venkateswara Rao (2014) and test after 7 and 28 days. Through their experiment, they concluded that at a 0.3% replacement of fine aggregates, It is possible to raise the concrete paver blocks' flexural strength and water absorption capacity without affecting the paver bricks' compressive strength. They added 0.1%, 0.2%, 0.3%, 0.4% and 0.5% in concrete by volume. They performed various test on concrete fibers and compressive, flexural and water absorption test in the paver blocks.[28]

S. Revathi, Dr. R. Kumutha and Dr. K. Vijai performed an experiment named as “Properties of Paver Blocks with Groundnut Husk Ash as fine aggregates”. They used groundnut ash at a percentage of 0, 10, 20, 30, 40, 50, and 60 to replace fine aggregates. Their analysis of the material's compressive strength, water absorption, and density showed that it was useful in construction.

They took M40 mix for their experiment. The physical properties of the fine aggregates which are river sand and groundnut husk ash as per Indian standards. The various analysis was shown in Table no 2.7 below. In addition to this they also calculated the specific gravity of coarse aggregates and cement too.[29] The mix proportion of their experiment subjects were made at a ratio of 1:2.83:2.48 at a water cement ratio of 0.5. They made 42 paver blocks, 6 paver blocks of each ratio.

By their experiment of density, they came to the conclusion that when groundnut ash was mixed in at a 30% percentage, the density of the paver blocks dropped. Under 2000 kg per cubic meter is where it falls. The compressive strength test shows a reduction with respect to controlled specimen without groundnut husk ash is about 4%, 10%, 15%, 24%, 37% and 48% respectively. The water absorption test shows an increase with respect to controlled specimen by 18%, 40%, 76%. 92%, 128% and 186% [29]. The test results are shown in table 2.8.

A sedimentary rock type made up of quartz, feldspar, and other minerals is called sandstone. Since feldspar and quartz are the most prevalent minerals in the crust of the Earth, they can be found in most sandstones, regardless of the place in which they are found. Sandstone is created when sediments are carried by wind or the air, compacted deposits press against each other, and then minerals precipitate to form cement. The main location that produces sandstone is Rajasthan, which is the largest state in terms of area in India. Even though the region's sandstones are widely utilized for paving, flooring, and roofing, the mining process produces a huge amount of sandstone trash.

Thermogravimetric analysis and scanning electron microscopy were used to examine the concrete samples. The concrete samples with quartz sandstone aggregates had higher vacancy fractions, as the microscopic analysis showed. Based on the decreased weight loss after heating, it was discovered that these void fractions improved the thermal resistance of concrete. It was also hypothesized that these void fractions improved insulating characteristics by obstructing the material's ability to conduct heat. The effective use of these waste quartz sandstone materials in concrete can help cut down on the significant amount of landfill space required for their disposal. It can also be a vital source of additional aggregate used to make cement concrete, which adds to the material's overall sustainability. Compose a paragraph without using punctuation.

A rock composed of sand-sized granules is referred to as sandstone. Ninety percent of the grains in quartz sandstones are quartz, with a small percentage of feldspars and lithic fragments. These quartz sandstones are typically cemented by silica, which holds the sand-sized grains together, and they are classified as mature or sub-mature sedimentary rocks. Due to diverse forms of sediment transit, the majority of quartz sandstones display textural and compositional maturity according to sedimentology. Upper shore-face and shallow seashore locations are the two most frequent depositional settings that yield quartz sandstones. Aeolian processes also play a major role in this process.

Very little research has been done on the thermal impacts of concretes including quartz sandstone aggregates, despite some literature focusing on the different varieties of sandstone and how much they affect the strength of concrete. Large volumes of sandstone debris are produced in India's northern states, such as Rajasthan. These wastes' disposal is a serious environmental and social issue. Recycling these wastes as aggregate to make new concrete can help preserve natural aggregate supplies and lessen the waste problem (Peem Nuaklong et al., 2016). The prod action of raw materials and the delivery of completed goods are two ways that the building and construction sector raises carbon emissions (Yun Zhong and Peng Wu, 2015). Additionally, according to Payam Shafigh et al. (2016), one of the main sources of the high volume of natural resource consumption is the concrete sector.

III. LITERATURE REVIEW

3.1 General:

In this experimental study, we will conduct a series of tests on fine aggregate and coarse aggregate. Tests have been conducted on interlocking tiles made from different blends of M40, employing quartz stone and fly ash, to assess their various strengths. Below are the examinations conducted on paver blocks

3.2 Modified mixed concrete paving blocks will be subjected to the following tests:

- Compressive Strength Testing
- Flexural Strength Testing
- Splitting Tensile Strength

3.3 Testing Test on Coarse Aggregate:

3.3.1 Specifics Gravity Test:

For this experiment, we need a balance with a capacity of 10 Kg, cylindrical containers with capacities of 1 liter" with “a volume of 1 liter" and "5 liters" with "a volume of 5 liters, to be A measuring jar with a capacity is 1000ml, calibrated for precise volume measurements.". We gauge the weight of the container when it's empty. denoted as W1. Coarse aggregate is then placed into the container until it's approximately half full, and the weight (W2) is determined. Next, water is added to the container until it reaches Adjusting the coarse aggregate level to ensure complete filling of all void spaces within the aggregate. The weight of this water-filled container is recorded as W3. Subsequently, the container is emptied of its mix of coarse aggregate and water, refilled with water up to the same level as before, and weighed (W4). This process is repeated for another trial with the container filled. Finally, the data collected is used in the following formula: [Formula to be inserted here].

Specific gravity = $W2 - W1 / ((W4 - W1) - (W3 - W2))$

The specific gravity that is recorded was 2.75 for trail 1, 2.68 for trail 2 and 2.54 for trail 3. The average specific gravity for the coarse aggregate is found to be 2.6567 or we can say that 2.66approximately.

3.3.2 Water Absorption test:

As per AASHTO M 231 regulations, we need a balance or scale that can hold 5 kg and be sensitive to 1 g. The sample container can hold aggregate with a nominal maximum size of 37.5 mm (1 1/2 in.) or less if it has a wire basket with mesh no greater than 3.35 mm (No. 6) and a capacity range from 4 to 7 L (1 to 2 gal). A larger basket might be needed for larger aggregates. The water tank should be watertight with an overflow valve to maintain a constant water level, large enough to fully submerge the aggregate and basket. Additionally, a suspension apparatus, sieves (including 4.75 mm - No. 4), and a large absorbent towel are needed.

To begin the testing process, the sample is dried at 110 ±5°C (230 ±9°F) until it reaches a constant mass, then cooled at room temperature for 1 to 3 hours. Subsequently, the aggregate is immersed in room temperature water for 15 to 19 hours. After confirming that the water level in the immersion tank reaches "The balance is zeroed with the empty basket submerged in the water bath," says the overflow outlet height. The test sample is then taken out of the water. dried with an absorbent cloth and weighed to determine the saturated-surface-dry (SSD) mass.

The SSD sample is promptly positioned within the sample container and submerged in water kept at a consistent temperature of 23.0 ±1.7°C (73.4 ±3°F). Following a thorough shaking of the container to eliminate any trapped air, the weight of the submerged sample is documented. Subsequently, the sample is carefully extracted from the basket, ensuring no residue is left behind, and transferred into a container with a predetermined mass. Eventually, the test sample undergoes drying until reaching a stable mass, followed by cooling, before the relevant calculations are executed using the appropriate formula.

A = oven dry mass,

B = SSD mass, and

C = weight in water.

Absorption = $[(B-A) * 100]$

The water absorption test in trail 1 absorbed 0.8% of water by weight. For trail 2, the water absorbed is 0.7% and for last trail 3 it was 0.6%. The mean waters absorptions is 0.7%.

3.3.3 Fineness Modulus of Coarse Aggregate:

We require IS test sieves, fine wire cloth with a micron size of 4800, 2400, 1200, 600, 300, and 150, as well as square hole perforated plates in the following sizes: 75 mm, 40 mm, 20 mm, and 10 mm. We also need tray plates, a sieve shaker, and a weighing scale with a sensitivity of 0.1 percent. First, use the quartering procedure to separate 5 kg of coarse aggregate (with a nominal size of 20 mm) from the sample. Proceed to sieve.

The aggregate should be manually shaken over a clean, dry tray for at least two minutes using the following sieve sizes: 75mm, 40mm, 20mm, 10mm, and with mesh sizes of 480, 240, 120, 60, 30, & 15. Use a variety of motions during shaking, including back and forth, left to right, circular, clockwise, and counterclockwise, along with the odd jarring, to make sure the material travels over the sieve surface in various directions. Once you have recorded the weight maintained on each sieve in the prescribed order, use the accompanying formula to compute it.

Fineness Modulus: Sum of Cumulative percentage Wt. retained /100

The fineness modulus of the coarse aggregate calculated for the coarse aggregate is 6.86 as calculated.

3.4 Test on fine Aggregate:

3.4.1 Specific gravity:

We require a 10-kilogram capacity balance, as well as one- and five-liter cylindrical containers and a 1000-milliliter measuring jar. To find the value W1, weigh the empty 1000 ml measuring jar first. Next, find W2 by weighing the empty jar with 150 milliliters of sand. Lastly, use 150 ml of sand and 100 ml of water to weigh the empty jar. Sand + water + empty jar equals W3. Take out the sand and water mixture from the container, add water to fill it to volume V3, and then weigh it. Water + empty jar equals W4.

Specific gravity = Weight of solids / Volume of Solids W2 - W1 / ((W4 - W1) - (W3- W2))

Specific Gravity of fine aggregate is found to be 2.71

3.4.2 Fineness Modulus Test:

To conduct this test, you'll need IS test sieves with square hole perforated plates in sizes of 75mm, 40mm, 20mm, and 10mm, as well as fine wire cloth with mesh sizes of 4800, 2400, 1200, 600, 300, and 150 Micron. Additionally, you'll require a weighing balance with a sensitivity of 0.1 percent, a sieve shaker, and tray plates. Start Remove 1 Kg of sand from the sample by evenly distributing it onto a clean, dry plate. Next, organize the sieves in descending order based on mesh size. Number 480 should be placed at the top, with Number 15 at the bottom Make sure the pan is at the bottom and the cover is at the top while using the sieve shaking machine. Sand should be put in the upper sieve. (Number 480) and sieve it for at least 10 minutes. Finally, record the weight retained in each sieve.

Fineness Modulus: Sum of Cumulative percentage Wt. retained /100.

3.4.3 Water Absorption Test:

Apparatus required include a wire basket with wire hangers for suspension water-tight container for suspending the basket" as "sealed container to hang the basket", and rewrite "dry soft absorbent cloths" as "absorbent cloths devoid of moisture Lastly, substitute "shallow tray" with a tray that is at least 650 square centimeters in size and an airtight container that is comparable in size to the oven and basket. The sample needs to be well cleaned to remove dust and smaller particles. It then needs to be drained and put in the wire basket, where it will be immersed in distilled water at a temperature of between 22 and 32°C. The basket needs to be raised and lowered 25 times in a 25-second period to release trapped air. After that, the basket and sample need to be kept underwater for more than twenty-four hours. Following this immersion, remove the aggregates and basket, let them drain for a short while, and then carefully pour them onto one of the dry cloths. With the cloth in hand, once the first cloth is no longer able to remove moisture, the aggregates should be gently surface-dried and moved to the second dry cloth." After spreading the aggregates out on the second piece of cloth, let them air dry away from direct sunlight until they appear completely dry on the surface. The aggregates are then weighed (Weight ‘A’). Following this, for a full day, the aggregates are kept in an oven at between 100 and 110°C. The aggregates are weighed once more (Weight 'B') after cooling.

Formula used is Water absorption = [(A – B)/B] x 100%.

The water absorption test is conducted for three trails as per standard procedure as discussed. The mean water absorption is 1.21%

3.5 Test for Cement:

3.5.1 Test for Cements Specific Gravity (IS: 269 -1989 AND IS: 4031-1988):

To ascertain specific gravity, you'll need a 50ml capacity bottle, physical balance, and clean kerosene. Start by ensuring the bottle is clean and dry, then seal it with the stopper (W1) and measure its weight. Fill the bottle halfway with the cement sample. weigh it with the stopper (W2) and avoid trapping air bubbles. Next, fill the bottle with kerosene (ensure its water-free), seal it, and weigh it (W3). After each weighing, clean and dry the bottle. Refill it with new kerosene and re-measure its weight (W4). Empty the kerosene, fill the bottle with water, and weigh it with the stopper (W5). All measurements should be taken at room temperature, ideally 27°C ± 10°C.

Specific gravity of Kerosene Sk = W4 - W1 / W5 - W1

Specific gravity of Cement Sc = W2 - W1 / ((W4 - W1) (W3- W2)) *Sk

Sc= (W2 - W1)* (W4 - W1) / ((W4 - W1)-(W3-W2))*(W5 - W1)

Specific Gravity of Cement is found to be 3.15 as the conducted experiment is done.

3.5.2 Fineness of Cement (IS: 269-1989 and IS:4031-1988):-

An IS-90-micron sieve that complies with IS: 460-1965, a standard balance, weights, and a brush are among the necessary tools. Measure out 100 g of cement precisely, then place it on a normal IS 90-micron sieve. Using your fingers, break apart any air- set lumps in the cement sample. Sieve the sample continuously for 15 minutes in both circular and vertical motions. Finally, weigh the residue that is still on the sieve. In accordance with IS guidelines, the residue percentage must not go above 10%.

Fineness of Cement is found to be 3% .

3.5.3 Normal Consistency of Cement (IS: 269 - 1989 and IS: 4031 - 1988 (Part1)

For these investigations, the Vicat apparatus uses a 10 mm diameter plunger, balance, weights, and gauging trowel in accordance with IS: 5513 - 1976 specifications. To make a combination, 300 grams of cement and a defined amount of distilled or drinkable water are combined, starting at 26 percent of the cement weight. Making ensuring the mixing takes three to five minutes and is finished before the setting starts is crucial. The measurement of mixing time starts when water is applied to dry cement and ends when mold filling is initiated. Poured into the Vicat mold, which is set on a non-porous plate, is the mixture. After filled, the surface is cut to match the mold's top, and gently shake the mold to get rid of any air bubbles. The non-porous plate is used to support the plunger rod (10mm diameter), which is positioned beneath the test block containing the mold. After that, the plunger is swiftly released to enter the mixture after being carefully lowered to touch the test block's surface. As soon as the mold is filled, this procedure is done. To find the necessary water content for reaching the desired consistency, a variety of experimental combinations with varying water percentages are made and examined. A proportion of the dry cement weight is used to express the water content.

The normal consistency found for cement is 35% for proper mixing and for better results.

3.5.4 Initial and Final Setting Times of Cement (IS: 269- 1989 &IS: 4031-1988 part 5):

Create a smooth cement paste by mixing 300 grams of cement with 0.85 times the necessary water to achieve a standard consistency. Use potable or distilled water for this mixture. Follow the designated procedure and conditions for determining the consistency of standard cement paste. Begin timing as soon as the water is added to the cement. Pour the cement paste into the mold positioned on a nonporous surface, ensuring the mold is filled and leveled off. Even out the surface of the paste until it aligns with the top of the mold. This cement block, prepared in this way within the mold, serves as the test block.

Determination of Initial Setting Time:

Position the testing block within the mold and position the impermeable plates under the rods that support the initial setting needle. Gently lower the needle until it contacts the surface of the test block, then quickly release it to allow it to penetrate into the material. Initially, the needle will penetrate the test block completely. Repeat this procedure until the needle, upon contact and release as previously described, cannot penetrate the block beyond a point that indicates the start setting time, which is 5 to 7 mm from the mold's bottom. Determination of Final Setting Time:

Replace the needle of the Vicat apparatus with another one outfitted with an annular attachment. Cement is considered fully set when, upon softly pressing the needle onto the test block's surface, it creates an indentation while the attachment does not. The duration between adding water to the cement and the moment the needle leaves an impression on the test block's surface while the attachment remains unaffected is regarded as the final setting time.

Initial setting time for the cement = 16 min

Final setting time for the cement = 625 minutes or 10hrs 25 mins.

3.5.5 Compressive Strength of Cement (IS 269-1989, IS 8112-1989, IS 12269 - 1987, IS 4031-1988 (Part4) & IS:4031-1988)

Mix proportions and mixing:

Use hygienic appliances for mixing, and ensure the water temperature and the temperature of the testing environment during these operations are 27 ± 2°C. In a container, weigh out one part cement to three parts ordinary sand. Using a trowel, thoroughly mix the ingredients for one minute, then add water to get a consistent color.

The volume of water to be used must comply with the guidelines listed below. To get a homogeneous hue, each component should be mixed for no more than four minutes. If it takes longer than this, the mixture will be considered unsatisfactory, and you will have to start over with a new batch of cement, sand, and water. The components for each cube must be combined separately using the following amounts of water, ordinary sand, and cement.

- Cements 200grams
- Standards sand 600 grams
- Water comprises (P/4 + 3.0) percent of the combined weight of cement and sand, where P represents the percentage of water necessary to create a paste of standard consistency.

Molding Specimens:

When preparing the moulds for use, spread a thin layer of petroleum jelly to seal the connections between the haves and between the mould bottom and its base plate, effectively preventing water from leaking during vibration. Additionally, apply mould oil to the interior surfaces of the mould. Securely clamp the assembled mould onto the vibration machine table. Attach a hopper to the mould top for easy filling, keeping it in place throughout the vibration process. Once the mortar is mixed, fill the cube mould and compact it by rodding 20 times in 8 seconds to remove air bubbles. Add more mortar to the hopper and rod again before compacting with vibrations. Vibrate for two minutes at 12,000 + 400 vibrations per minute. After vibration, remove the mould and base plate, then smooth the top surface with a trowel blade.

- Curing Specimen:

Maintain the filled moulds at a temperature of 27 ± 20 C in an environment with a minimum of 90% relative humidity for approximately 24 hours following the conclusion of vibration. At the conclusion of this timeframe, Take the cubes out of the moulds and promptly immerse them in fresh, clean water, ensuring they remain submerged until testing. Change the water every 7 days, maintaining it at a temperature of 27°C ± 2°C. Prevent the cubes from drying out from the moment they are removed until they undergo testing.

- Testing:

At certain intervals, test three cubes to determine their compressive strength in compliance with the pertinent standards for different types of hydraulic cements. These intervals are calculated based on the vibration's completion. It is necessary to compute the three cubes' average compressive strength for each curing interval. Cubes must be tested on their sides with no extra material positioned in between them and the testing machine's steel plates. The load should be applied consistently and steadily starting at zero and at a rate of 350 kgs/cm2/min. One platen should act as the base and self-adjust. The following are the testing intervals for various cement types: regular Portland cement at 3, 7, and 28 days; quick-setting Portland cement at 1 and 3 days; Three and seven days of low heat Portland cement.

- Calculations:

Determine the compressive strength by assessing the crushing load and dividing it by the average area of application. Round the results to the nearest 0.05 mm2 and express them in N/mm2.

The formula for compressive strength is expressed as:

Compressive strength (N/mm^2) = P/A,

where P represents the crushing load in Newtons (N) and A denotes the area in square millimeters (mm^2), with a standardized value of 5000 mm^2.

This equation allows for the determination of the average compressive strength of the provided cement sample.

At 3 days N/mm2 = 18.92 N/mm2

At 7 days N/mm2 = 27.63 N/mm2

At 28 days N/mm2= 43 N/mm2

3.5.6 Soundness of Cement (IS 269-1989 AND IS 4031-1988 PART3):

An IS 5514-1969-compliant Le Chatelier equipment will be used in the experiment. Starting with a lightly oiled moulds set over a lightly oiled glass sheet, fill the mould with cement paste made by combining cement with 0.78 times the amount of water needed to make a standard consistency paste. In order to determine the consistency of standard cement paste, gauge the paste according to the instructions provided, making that After the mold's edges are carefully pressed together, cover it with another glass sheet and lay a little weight on top. Next, immerse the complete assembly in water that is between 27°C and 20°C for a full day. Next, determine how far apart the indicator points are from one another. Repeat the submersion of the moulds in water at the specified temperature. Bring the water to a boil and keep the mould submerged for 25 to 30 minutes, maintaining boiling for three hours. After removing the mould from the water, let it cool, and measure the distance between the indicator points again. The difference between these two measurements indicates the expansion of the cement. Ideally, this expansion should not exceed 10mm for high- quality cement.

For the Soundness test we prepared 3 specimens. The expansion noted is 3mm, 4mm and 3mm. The average expansion noted is 3.33mm

3.6 Test on Paving Blocks:

3.6.1 Test of Compressive strength:

We needed molds for paving blocks (with IS Mark certification), an electronic weighing balance, G.I sheet (for concrete production), a vibrating needle, and various other tools, along with a compression testing machine.

- Cube Casting:

Measure the dry proportion of ingredients (Cement, Sand & Coarse Aggregate) as per the design requirements. The ingredients should be enough to cast test cubes.

Thoroughly mix the appropriate amount of water with the dry proportion (water- cement ratio) and blend well to achieve a uniform texture.

Fill the cube the concrete into the mold using a vibrator to ensure complete compaction. Smooth the surface of the concrete with a trowel, tapping it well until the cement slurry rises to the top of the cubes.

- Curing:

After a predetermined amount of time, cover the area with a red cloth bag and leave it alone at 27°C ± 2 for a whole day. Once this time has passed, take the sample out of the container. The sample should be submerged in fresh water at 27°C and let to soak for seven to eighteen days. Refresh the water every 7 days. Thirty minutes prior to testing, withdraw the sample from the water and ensure it is dry. The weight of the cube must be a minimum of 8.1 kilograms.

- Testing:

Now, place the concrete cubes into the testing machine. Ensure correct placement on the machine plate by aligning them with the circle marks. Carefully position the specimen on the spherically seated plate. Apply the weight gradually until the cube collapses, at a rate of 140 kg/cm2 per minute. Calculate the compressive load in kilos and note the highest load at which the specimen breaks.

Compressive Strength of concrete = Maximum compressive load / Cross Sectional Area

3.6.2 Test of Flexural Strength:

Prepare the test specimen by filling the concrete into the mould in three layers of approximately equal thickness. As mentioned above, compact each layer 35 times with the tamping bar. Make sure that the compaction is consistent across each layer's depth and the beam mold's whole cross-section. Clear any loose dirt from the specimen surfaces that will encounter the rollers and clean the bearing surfaces of the loading and supporting rollers. The specimens will be supported and loaded by 38 mm-diameter steel circular rollers. The rollers' length must be at least 10 mm greater than the test specimen's breadth. In total, four rollers will be utilized, with three of them having axes for rotation. The distance between the inner rollers should be evenly spaced, and the outer rollers (span) will bend according with the distance between them.

Positioned to guarantee that the system as a whole keeps the same configuration between the outer rollers. Testing needs to be done as soon as specimens kept in water are removed, while they are still wet. Ascertain that the test specimen's longitudinal axis is perpendicular to the rollers by properly aligning it within the apparatus. When it comes to molded specimens, the loading direction and the mold's filling direction should be perpendicular. Use a load application rate of 400 kg/min for specimens measuring 15.0 cm and 180 kg/min for specimens measuring 10.0 cm.

The Flexural Strength or modulus of rupture (fb) is given by: -

fb = pl÷bd2

"When the length exceeds 20.0cm for a specimen measuring 15.0cm or surpasses 13.0cm for a specimen of 10cm.

OR

fb = 3pa÷bd2

When a specimen measures less than 20.0cm but greater than 17.0cm for a 15.0cm specimen, or less than 13.3cm but greater than 11.0cm for a 10.0cm specimen:

Where, a is the measurement made along the centerline of the specimen's tensile side, representing the distance between the closest support and the fracture line.

b stands for the specimen's width in centimeters.
d denotes the depth at which failure occurs in centimeters.
l signifies the length of support in centimeters.
p represents the maximum load in kilograms. The Flexural strength of the concrete is reported to two significant figures.

3.6.3 Splitting Tensile Strength Test (IS-516): -

Placing the Specimen in the Testing Machine:

To prevent any loose particles, such sand or other debris, from getting in the way of the specimen, the surfaces of the loading and supporting rollers need to be completely cleaned. For each specimen, two thin strips of flawless plywood, approximately 1/8 inch thick (3.175 mm) and 25 mm wide, should be prepared. These strips will be placed between the specimen and the upper and lower bearing blocks of the testing machine, or between the specimen and any additional bars or plates.

Diametrical lines should be marked on each end of the specimen to ensure alignment in the same axial plane. One plywood strip should be positioned centrally along the lower bearing block, with the specimen placed on top, aligning the marked lines vertically and centering them over the plywood. Another plywood strip should be placed lengthwise on the cylinder, aligning it with the marked lines on the cylinder ends.

A continuous load should then be applied at a steady rate, ranging from 689 to 1380 kPa/min to measure splitting tensile stress until the specimen fails. Record the maximum load applied at failure, along with noting the type of failure and fracture appearance. Finally, calculate the splitting tensile strength of the specimen using the appropriate formula.

$T = 2P/\pi LD$

Were,

T = Splitting tensile strength

P = Maximum applied load

L = Length, m

D = Diameter

3.7 Materials:

The following materials were brought from the Building Material Market Near Moser- Baer Factory, Moser-Baer Gol Chaker, Surajpur for the experiment.

- Jaypee Cement OPC of Grade43.
- Coarse aggregates 10-20mmsize.
- Fine Aggregate i.e. Sand.

For Quartz stone chips we collected from a quartz vendor at Lal Bagh Loni. These quartz stones are a mixture of different quartz stones. These stones were further broken into pieces of size 10-20mm.

3.8Concrete Preparation (IS 456 :2000):

3.8.1. Requirement of concrete mix design:

The prerequisites that establish the foundation for selecting and proportioning mix ingredients are:

A) The least amount of compressive strength required to maintain structural integrity.

B) Sufficient workability needed for complete compaction using the available compacting equipment.

C) The maximum permitted cement content and/or water-to-cement ratio to ensure sufficient durability given the specific site conditions.

D) The highest cement concentration that can be used to reduce shrinkage cracking in mass concrete caused by temperature changes.

3.8.2. Types of Mixes:

Nominal Mixes

Historically, concrete specifications outlined the ratios of cement, fine and coarse aggregates. These ratios, known as nominal mixes, maintained a consistent cement- aggregate ratio to guarantee sufficient strength. Nominal mixes provided simplicity and typically exceeded the specified strength requirements under usual conditions. Nonetheless, the variability of ingredients in these mixes often led to significant differences in strength for concrete of the same workability.

Standard mixes

In earlier times, concrete specifications outlined the ratios of cement, fine aggregates, and coarse aggregates. These ratios, known as nominal mixes, maintained a consistent cement-aggregate ratio to guarantee sufficient strength. Nominal mixes provided simplicity and typically yielded strength levels surpassing the specified requirements under standard conditions. Nevertheless, the inherent variability in mixed components results in significant variations in strength for nominal concrete of the same workability.

M35, M40, and IM30. The mixture is represented by the letter M in this nomenclature system, and the number indicates the mixture's stipulated 28-day cube strength in N/mm2. The mixing proportions of grades IM10, IM15, IM20, and IM25 generally match the following mixtures: 1:13:6, 1:2:4:3, 1:1:1.5:3, and 1:1:2:2.

Designed Mixes:

In these blends, the concrete's performance is specified by the designer, while the mix proportions are determined by the concrete producer, except for setting a minimum cement content. This method is the most logical approach for selecting mix proportions tailored to specific materials with varying characteristics. It guarantees the lowest possible cost while producing concrete with the required qualities. However, relying solely on the specified blend doesn't guarantee the precise balance of desired attributes. In situations where concrete performance demands are moderate, standard mixes (outlined in codes by dry ingredient quantities per cubic meter and slump) might be adequate, particularly for smaller projects where the 28-day concrete strength stays below 30 N/mm2. There's no need for rigorous testing in these instances, as the emphasis is on the proportions of ingredients.

Factors influencing the selection of mix proportions include:

- Compressive strength
- Workability
- Durability
- Maximum nominal size of aggregate
- Grading and type of aggregate
- Quality Control

- Mix Proportion designations

3.8.3. Procedure:

Using the specified compressive strength at 28 days, fck, and the level of quality control, compute the average target strength, ft.

ft = fck + 1.65 S

In the absence of a plague, the table of approximate contents that is presented following the design mix is where the standard deviation (S) is found. The empirical relationship between compressive strength and water-cement ratio is used to calculate the water-cement ratio for the intended mean target. To assure durability, this selected ratio is then compared to the limiting water-cement ratio, as shown in the table, and the lower of the two values is chosen. The amount of entrapped air for the maximum nominal size of the aggregate is estimated from the table. Water content is selected for the required workability and maximum size of aggregates from the table, considering aggregates in a saturated surface dry state. The percentage of fine aggregate in the total aggregate is determined by absolute volume from the table for concrete using crushed coarse aggregate. Values of water content and percentage of sand are adjusted according to variations in workability, water-cement ratio, and fine aggregate grading. Cement content is calculated from the water-cement ratio and final water content after adjustment. Cement content is checked against the minimum required for durability, and the greater of the two values is chosen. Finally, based on the previously estimated proportion of sand, the amounts of water, cement, and coarse and fine aggregates per unit volume of concrete are computed.

C **1**

V=[W+ +]× 1

$Sc\ pSfa$ 1000

C 1

V= [W+ 1] × 1

Sc 1−$pSca$ 1000

Subtract the volume of trapped air from the gross volume (1m3) to find the absolute volume of concrete (V).

Determine the specific gravity of cement (Sc).

Calculate the mass of water (W) per cubic meter of concrete, as well as the mass of cement (C) per cubic meter.

Define the ratio of fine aggregate to total aggregate by absolute volume (p).

Determine the masses of fine (fa) and coarse (Ca) aggregates per cubic meter of concrete, along with their respective specific gravities of saturated surface dry aggregates (Sfa and Sca). Establish the concrete mix proportions for the initial trial mix. Utilize these proportions to prepare the concrete and cast three 150 mm cubes. Test these cubes after 28 days of moist curing to assess their strength. Make necessary adjustments to the trial mixes until arriving at the final mix proportions.

3.9 Material Preparation:

The concrete mixture is created by blending materials in a ratio of 1 part cement, 2 parts sand, and 3 parts aggregate by weight. Different percentages (0%, 10%, 20%, 30%, 40%, 50%, and 60%) of the coarse aggregate were substituted and then subjected to testing.

IV. RESULTS AND DISCUSSION

4.1 General:

The results of the present investigation are presented both in table and graphical forms.

Explanation of the results is carried out at each phase of experiment work" The previous chapter provided an overview of the tests and methods used. The analysis of our experiment included.

- Coarse aggregate of size Ten to Twenty mm.
- Fine Aggregate
- Ordinary Portland Cement of Grade43

- Quartz Stone chips of size 10-20mm

Further discussion will be dedicated to the analysis of the process and experimental results.

4.2 Covers the preparation of quartz stone.:

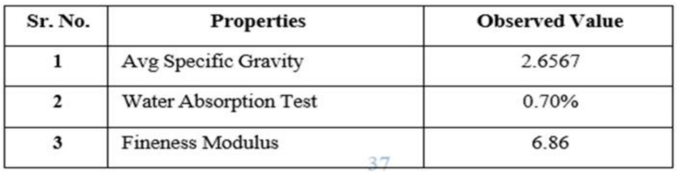
We obtained quartz stones from the market in various sizes. These stones required further processing to break them into smaller pieces and sift them for selecting suitable replacements for coarse aggregate. We instructed the market worker to break the stones into pieces approximately 10-20mm in size. Following this, we sifted the broken pieces through a sieve within that size range, retaining the stones that passed through for use in our experimentation.

4.3 Test on Coarse Aggregate:

Results of various test:

Discussion:

Table 4.1: The properties of coarse aggregates.



Sr. No.	Properties	Observed Value
1	Avg Specific Gravity	2.6567
2	Water Absorption Test	0.70%
3	Fineness Modulus	6.86

The Table 4.1 presents the condensed results.

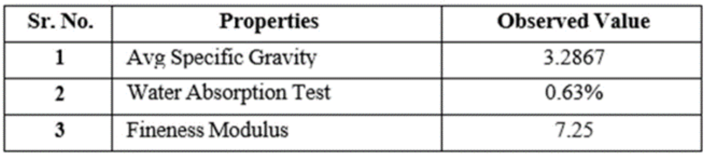
The findings from multiple tests indicate that the calculated values fall within the parameters outlined in ISO 9001:2008. Any slight discrepancies could be attributed to variations in temperature and human error.

Results of various test:

Discussion:

The quartz stones used in our experiment do not conform to any standard specifications. However, the results obtained closely resemble those reported by Khandvi, P. V., and Rathi, A. S. Discrepancies in results can be attributed to their use of a specific type of quartz stone, whereas our experiment employed various quartz stone mixtures. The diverse properties of quartz stones are detailed in Table 4.2 below. Table 4.2 presents the condensed results.

Table 4.2: Properties of Quartz Stone



Sr. No.	Properties	Observed Value
1	Avg Specific Gravity	3.2867
2	Water Absorption Test	0.63%
3	Fineness Modulus	7.25

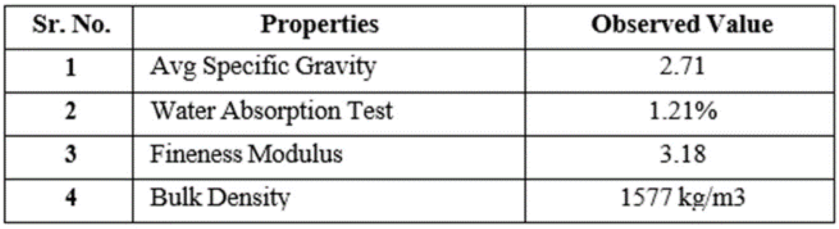
4.3.1 Results of various test:

Discussion:

The test Findings show that the fine aggregates have advantageous physical qualities. The sand was utilized in our investigation. Like natural river sand, it nearly matches the characteristics recorded by Revathi, S. etal.as well as other references are included in that2.

The summarized results are presented in Table 4.3

4.3: Properties of Fine Aggregates.



Sr. No.	Properties	Observed Value
1	Avg Specific Gravity	2.71
2	Water Absorption Test	1.21%
3	Fineness Modulus	3.18
4	Bulk Density	1577 kg/m3

4.4. Test for Cement:

Results:

Discussion:

The test results illustrate the cement's qualities in line with ISO 9001:2008 requirements. Human error and temperature fluctuations may cause small variances.

Table 4.4 below displays the outcomes of the experiment.

4.5 Covers the preparation of concrete.

4.5.1 Quantity estimation:

Target Mean Strength = 48.25n/mm2

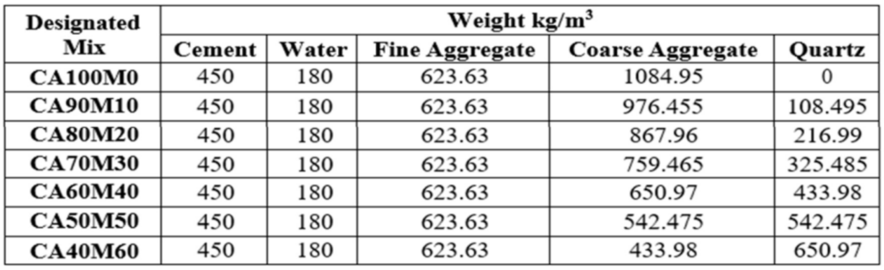
Water Cement Ratio = 0.4 (from IS 456:2000 table no 5) Water Content = 180 kg

Estimated Air Entrapped = 2% Cement Content = 450 kg

Fine Aggregate = 623.63 kg/m3 Coarse Aggregate = 1084095 kg/m3

4.5.2 Quantity after replacement with quartz stone

Table 4.5: Quantity of Components.



Designated Mix	Weight kg/m³				
	Cement	Water	Fine Aggregate	Coarse Aggregate	Quartz
CA100M0	450	180	623.63	1084.95	0
CA90M10	450	180	623.63	976.455	108.495
CA80M20	450	180	623.63	867.96	216.99
CA70M30	450	180	623.63	759.465	325.485
CA60M40	450	180	623.63	650.97	433.98
CA50M50	450	180	623.63	542.475	542.475
CA40M60	450	180	623.63	433.98	650.97

The concrete is formulated by blending according to the mix proportion of M40, with variations in the coarse aggregate proportion at 0%, 10%, 20%, 30%, 40%, 50%, and 60%. The quantities of each component are detailed in the subsequent table 4.5.

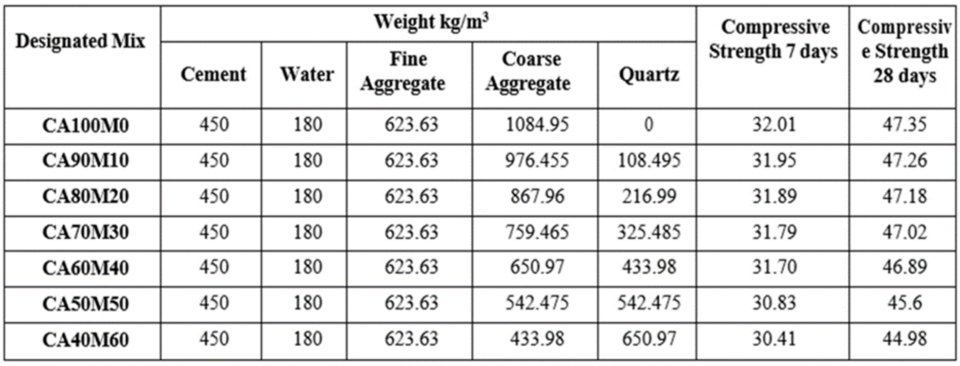
4.6. Test on Paving Bricks:

4.6.1 Test of Compressive strength:

Compressive strength test was conducted. The highest recorded compressive strength for three paver bricks of each mixture was graphically represented. Notably, the CA100M0 mixture exhibited the maximum compressive strength, peaking at 47.35 N/mm², whereas the lowest value of 44.98 N/mm² was observed for the CA40M60 mix. Detailed data regarding the varied values obtained during the experiment are comprehensively presented in Table 4.6, with a corresponding graphical representation depicted in Graph 4.1. These findings offer valuable insights into the performance and characteristics of the different paver brick mixtures, aiding in informed decision- making for construction projects.

When the concentration of quartz stones is increased, we found that the compressive strength only slightly decreases (from 47.35 N/mm2 to 46.89 N/mm2) up to a 40%

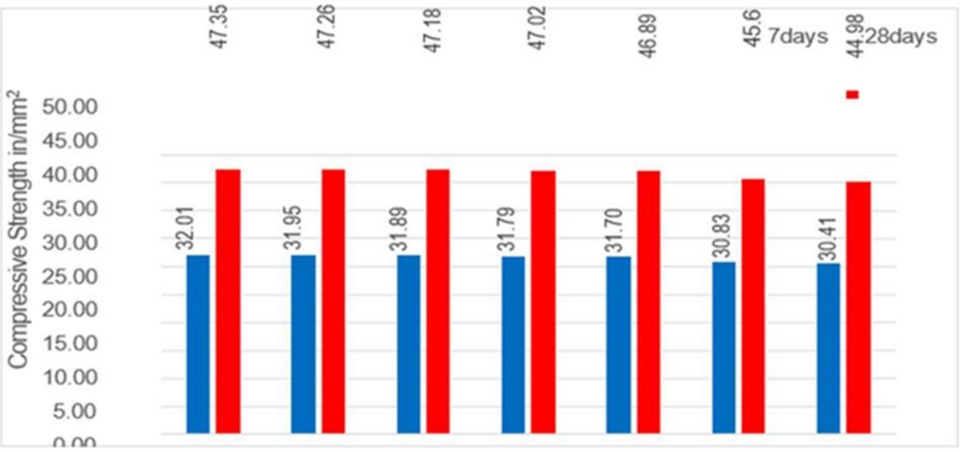
Table 4.6: Compressive strength test results for paver brick



Designated Mix	Weight kg/m³					Compressive Strength 7 days	Compressive Strength 28 days
	Cement	Water	Fine Aggregate	Coarse Aggregate	Quartz		
CA100M0	450	180	623.63	1084.95	0	32.01	47.35
CA90M10	450	180	623.63	976.455	108.495	31.95	47.26
CA80M20	450	180	623.63	867.96	216.99	31.89	47.18
CA70M30	450	180	623.63	759.465	325.485	31.79	47.02
CA60M40	450	180	623.63	650.97	433.98	31.70	46.89
CA50M50	450	180	623.63	542.475	542.475	30.83	45.6
CA40M60	450	180	623.63	433.98	650.97	30.41	44.98

Substitution. But after this point, the paver brick's compressive strength starts to deteriorate more quickly. At a 60% substitution of coarse aggregate for quartz stone, the lowest value ever measure was 44.98 N/mm2. In their experiment, Khandve P. V. and Rathi A.S. observed this behavior.

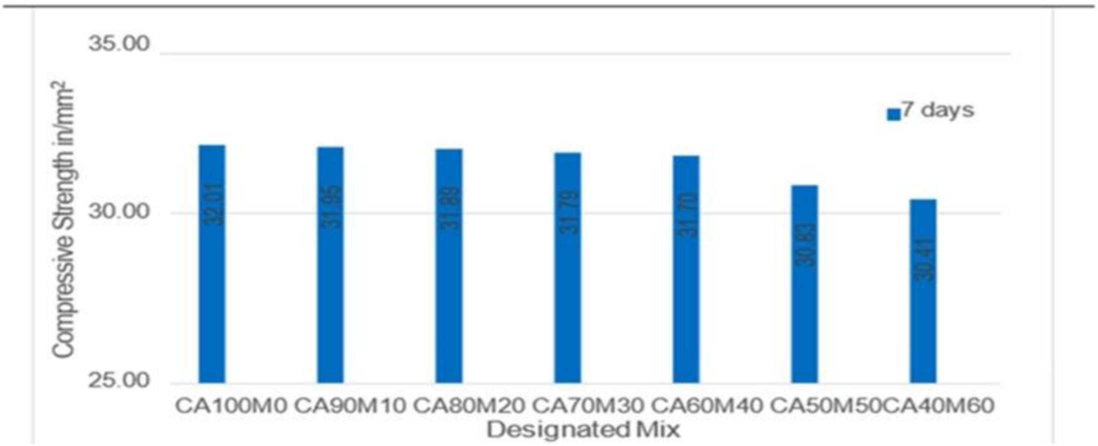
Where they investigated the use of waste from the Quartz stone industry in paving bricks for concrete pavements. They recorded a maximum value of 47.35 N/mm2. Variations in their results were attributed to atmospheric conditions and the diverse types and qualities of quartz stones utilized as replacements for coarse aggregates.



Graph No. 4.1: Compressive strength observed during experiment.

Table 4.7: Test result of compressive strength (7 days) of paver brick

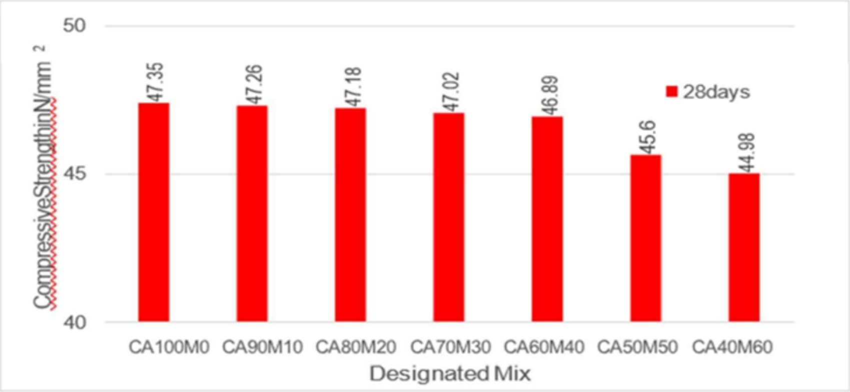
Designated Mix	Weight kg/m^3					Compressive Strength
	Cement	Water	Fine Aggregate	Coarse Aggregate	Quartz	
CA100M0	450	180	623.63	1084.95	0	32.01
CA90M10	450	180	623.63	976.455	108.495	31.95
CA80M20	450	180	623.63	867.96	216.99	31.89
CA70M30	450	180	623.63	759.465	325.485	31.79
CA60M40	450	180	623.63	650.97	433.98	31.70
CA50M50	450	180	623.63	542.475	542.475	30.83
CA40M60	450	180	623.63	433.98	650.97	30.41



Graph No. 4.2: Compressive strength at 7 days observed during experiment.

Table 4.8: Test result of compressive strength (28 days) of paver brick

Designated Mix	Weight kg/m^3					Compressive Strength
	Cement	Water	Fine Aggregate	Coarse Aggregate	Quartz	
CA100M0	450	180	623.63	1084.95	0	47.35
CA90M10	450	180	623.63	976.455	108.495	47.26
CA80M20	450	180	623.63	867.96	216.99	47.18
CA70M30	450	180	623.63	759.465	325.485	47.02
CA60M40	450	180	623.63	650.97	433.98	46.89
CA50M50	450	180	623.63	542.475	542.475	45.6
CA40M60	450	180	623.63	433.98	650.97	44.98

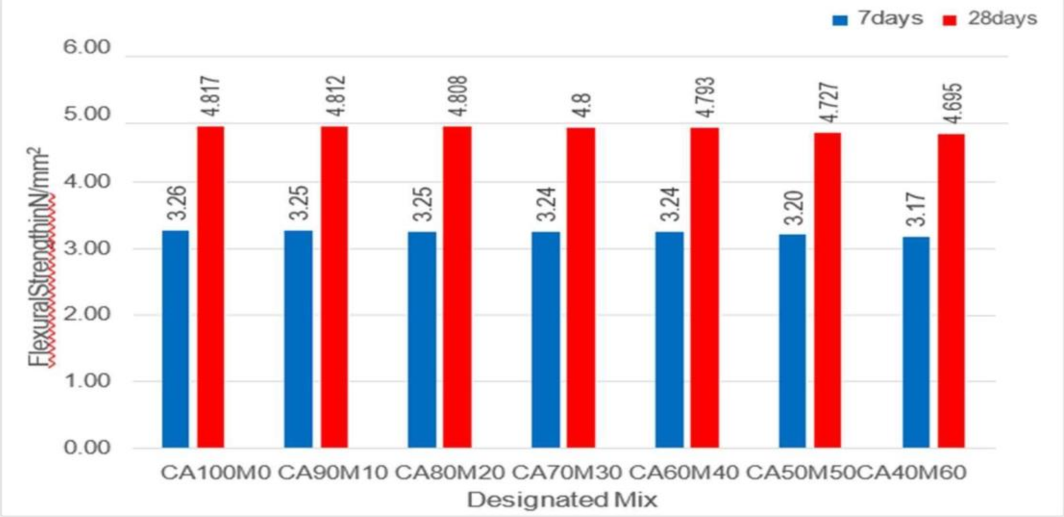


Graph no 4.3 Compressive strength at 28 days observed during experiment.

4.6.2. Test of Flexural Strength:

In accordance with the procedures outlined in Chapter 3, the evaluation of Flexural strength is conducted. Graphs are constructed to illustrate the maximum flexural strength derived from three paver bricks of each mixture. Notably, the CA100M0 mixture exhibits the highest recorded value at 4.817 N/mm^2, while the lowest value is observed for the CA40M60 mixture at 4.695 N/mm^2. Additional data from the experiment is provided in Table 4.7, and the corresponding graphical representation can be found in Graph No. 02. This comprehensive analysis offers valuable insights into the flexural performance of the various paver brick mixtures, aiding in informed decision-making for construction applications

Designated Mix	Weight Kg/m^3					Flexural Strength 7 days	Flexural Strength 28 days
	Cement	Water	Fine Aggregate	Coarse Aggregate	Quartz		
CA100M0	450	180	623.63	1084.95	0	3.26	4.817
CA90M10	450	180	623.63	976.455	108.49	3.25	4.812
CA80M20	450	180	623.63	867.96	216.99	3.25	4.808
CA70M30	450	180	623.63	759.465	325.48	3.24	4.8
CA60M40	450	180	623.63	650.97	433.98	3.24	4.793
CA50M50	450	180	623.63	542.475	542.47	3.20	4.727
CA40M60	450	180	623.63	433.98	650.97	3.17	4.695



Graph No. 4.4: Flexural strength observed during experiment.

Table 4.10: Test result Flexural strength 7 days of paver brick

Designated Mix	WeightKg/m^3					Flexural Strength 7 days
	Cement	Water	Fine Aggregate	Coarse Aggregate	Quartz	
CA100M0	450	180	623.63	1084.95	0	3.26
CA90M10	450	180	623.63	976.455	108.49	3.25
CA80M20	450	180	623.63	867.96	216.99	3.25
CA70M30	450	180	623.63	759.465	325.48	3.24
CA60M40	450	180	623.63	650.97	433.98	3.24
CA50M50	450	180	623.63	542.475	542.47	3.20
CA40M60	450	180	623.63	433.98	650.97	3.17

4.6.3. Splitting Tensile Strength Test of Concrete (IS-516):

As the proportion of quartz stones increases, a slight decrease in split tensile strength is noted, this variation may be attributed to factors such as atmospheric conditions and the diverse types and qualities of quartz stones used to replace the coarse aggregate. A minor reduction in split tensile strength is evident across different mixes, spanning from CA100M0 to CA40M60. The test, detailed in Chapter 3, sheds light on the impact of quartz stone waste on concrete pavement. In a similar experiment conducted by Khandve P. V. and Rathi A.S., a consistent maximum split tensile strength of 37.39 N/mm^2 was observed. Discrepancies in results could be attributed to atmospheric variations and discrepancies in the quality of quartz stones utilized. Table 4.8 and Graph 4.2 depict the diverse values obtained during the experiment, with each mix represented by three paver bricks. These findings underscore the complex interplay of materials and environmental factors in determining the mechanical properties of concrete pavement.

V. CONCLUSION

1. Similarly, the flexural strength of paver blocks remains unaffected when quartz stones are substituted for coarse material; up to 50% substitution has an estimated value of 4.817N/mm2.
2. S A split tensile strength can range from 4.4498 N/mm2 to 4.735 N/mm2. Up to 40% of the coarse aggregate can be replaced with quartz stone without significantly affecting split tensile strength; however, a slight decrease of up to 5% is detected
3. Split tensile strength ranges from 4.4498 N/mm2 to 4.735 N/mm2. Up to 40% of the coarse aggregate can be replaced with quartz stone without severely affecting split tensile strength; however, a slight decrease of up to 5% should be observed.

4. The split tensile strength, flexural strength, and compressive strength of the testing blocks show only minor variations from the original standard mix paver blocks, suggesting that quartz stone waste can be used in place of natural crushed stone in paver blocks.

Future Work Scope:

5. To broaden the scope of the dissertation's future work, employ the following strategy: By substituting quartz stone waste for coarse aggregate up to 100% of the mix ratio.
6. Modify the proportion of fine aggregate by adding fly ash, husks, etc.
7. The dissertation's future work scope can be increased by using the following strategy: • By increasing the mix ratio up to 100% replacement with quartz stone waste in place.
8. S A split tensile strength can range from 4.4498 N/mm2 to 4.735 N/mm2. Up to 40% of the coarse aggregate can be replaced with quartz stone without significantly affecting split tensile strength; however, a slight decrease of up to 5% is detected.
9. Split tensile strength ranges from 4.4498 N/mm2 to 4.735 N/mm2. Up to 40% of the coarse aggregate can be replaced with quartz stone without severely affecting split tensile strength; however, a slight decrease of up to 5% should be observed.
10. The split tensile strength, flexural strength, and compressive strength of the testing blocks show only minor variations from the original standard mix paver blocks, suggesting that quartz stone waste can be used in place of natural crushed stone in paver blocks.

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