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Experimental Studies on Paver Block Concrete Using Granite and Kota Stone Waste with Environment Affect on Strength

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ABSTRACT

The numerous stone wastes produced by the various processes in the stone industries are used to create convenient forms of stone. From the primary surplus, known as stone dust it is taken out to substitute the confident quantity of cement consumption in concrete due to its least price. By utilizing trash from the building industry, the issue of disposing of stone waste can be efficiently solved. In the current investigation, Kota stone chips and granite chips utilized in place of aggregate to examine the effects on various characteristics of the concrete mixtures. The characteristics of typical Kota stone and Granite chips in M25 concrete blocks are discussed in this study. Compressive strength, a crucial aspect of concrete, is discussed in the paper. The study shows that adding Kota stone debris to concrete had a good effect by making it stronger and more durable when done correctly.This is the first phase of the study in which kota stone waste is replaced with coarse aggregates to check the suitability of the waste with natural aggregates. It will help for further study.

Key words: *Durability Property, Environmental management, Kota Stone waste, Granite Waste, Sustainable Construction, Reuse.*

Introduction

One of the most often used building materials in historical times was stone. In recent years, stone usage has increased worldwide on a sustainable basis. There are many different kinds of stones used in construction, including granite, marble, limestone, slate, and others. Environmental issues may result from waste material created in open spaces. Therefore, it is vital to use this waste material in the construction industry. The need for natural aggregate is also increasing day by day. Stone waste can be used to avoid natural aggregates. Kota stone is typically utilized for several purposes, including floor decoration and wall cladding. It has outstanding stone resolvability, grease resistance, non-water absorption, and non-slip qualities. Slabs and tiles are available in this form. Deposits of Kota stone can be found in several Kota neighborhoods as well as the Jhalawar District in Rajasthan. As a result of waste chips created during the cutting process, the original Kota Stone mass is reduced by 20–25%. Although designated places have been marked for dumping, the kota Stone cutting plants continue to dump the chips in any neighboring pit or empty spaces close to their unit. This has a negative impact on the ecosystem, causes pollution, and occupies a sizable portion of the land. Waste from Kota Stone can be

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added to concrete to increase its durability and strength. Waste Kota Stone can be used to concrete to change its qualities in addition to being used as a partial substitute for fine or coarse aggregate. Granite stone waste can also used in concrete as replacement of coarse aggregates. From a different angle, a significant portion of the money spent on its transportation to landfills is due to the enormous volumes of stone waste that are produced in generation sources and plants. Additionally, from an economic standpoint, the buildup of waste in landfills is a serious issue for many firms. For quarry and fabrication firms, landfill fees might result in increased expenditures if waste must be disposed of off-site. Kota stone slurry waste is currently being dumped in an open area. Improper waste management has resulted in pollution, threats to human health and safety, land degradation, water ponding and flooding, visual impact, and aesthetic loss. It is necessary to transform these wastes, which are produced in vast quantities by different sectors, into valuable products by careful treatment and technological processing. India makes up 17.7% of the global population, which is projected to increase to 1500 million by 2030 and 1600 million by 2047, making it the world's most populous country. Over the coming decades, it is anticipated that the growth in population, urbanization, and income would increase, leading to an increase in material consumption. Additionally, garbage generation will multiply simultaneously. The use of mining waste, slurry waste, and limestone dust to research the mechanical properties of concrete has been extensively documented in the literature.

Denis Jangeed *et al.* (2019) studied on Replacing Certain Amount of Course Aggregate with Waste kota-stone chips and Make the Eco Friendly Paver Block. In this research they replace the certain amount of course aggregate by kota-stone waste chips accordingly in the ratio of (60:40) where 60% course aggregate and 40% kota stone respectively by weight for m-20 grade concrete. The compression strength test is carried out to evaluate the mechanical properties for 7, and 28 days. The compression strength test of paver block is 19.83 which is approx to 20 N/mm 2 . Use of waste kota stone chips make it eco-friendly and economical. Ganesh Nimbark *et al.* (2020) conducted research on Reusing Effectiveness of Kota Stone Quarry Residues on Concrete Mix Design. For inspect the efficacy of material, different percentage of kota stone aggregates (KSA) replace with natural aggregate (0%, 10%, 20%, 30%, 40%) and evaluated various mechanical characteristics of concrete mix. It was found that the 28 days specified characteristics compressive strength remained within limits of average 28 days compressive strength of 3 samples not less than 20 MPa for 40% of KSA.

Charat Ram Meena and Mahendra Saini (2022) studied on Kota Stone Slurry as Limited Replacement of Cement with Predictable and M-Sand Mixed Concrete. In which Auxiliary levels for Kota stone slurry were kept from 0 to 25% at an addition of 5%. Highest compressive strength is attained 53.1 MPa at 15% replacement. This increment was detected due to the pozzolanic nature of the Kota stone slurry. Kota stone slurry acts like additional cementitious material. Harshdeep Vani and Sahil Arora (2021) studied of concrete made with recycled concrete, bagasse ash, and kota stone dust. In which the varied Kota Stone ratios in the range of 5%, 10%, 15%, 20%, 25%, and 30% are used to prepare the concrete. Bagasse ash was used in proportions of 10%, 20%, 30%, and 40%, and recycled aggregate in proportions of 10%, 20%, 30%, and 40%. By acquiring an additional 5% in compression, 2% in flexure, and 2% in spilled tensile strength, recycled coarse aggregate can be optimally substituted up to 20% of the time in place of virgin coarse aggregate. Up to 40% of the mix for the M25 can be replaced by recycled coarse aggregate. Additionally, they discovered that Kota stone powder is probably finer than cement, increasing the compression strength by 15%, flexure strength by 3%, and split tensile strength by 7% when 15% of the weight of cement is substituted. Gupta and Sharma (2014) analyzed the effects of fly ash, Beas sand, and marble dust on the subgrade properties of expansive soil. The results of a series of laboratory tests on black cotton soil that had been stabilised with fly ash and sand and then mixed with 0% to 20% marble dust showed that 15% marble dust was adequate to enhance the California bearing ratio-soaked value by roughly 200%.

Impact of Kota stone slurry on the environment and humans

Kota stone slurry is a waste material generated during the processing of Kota stone, a popular natural stone used in flooring and wall cladding. The slurry is produced when the stone is cut and polished, and it consists of fine particles, water, and chemicals used in the stone processing industry. Here are some potential impacts of Kota stone slurry on the environment and humans:

Water pollution: Improper disposal of Kota stone slurry can lead to water pollution. If the slurry is released into water bodies such as rivers or lakes, it can contaminate the water, affecting aquatic life and biodiversity. The fine particles in the slurry can settle in the water, reducing water clarity and disrupting the ecosystem.

Soil contamination: Dumping Kota stone slurry on the ground can contaminate the soil. The slurry contains chemicals and fine particles that may leach into the soil, affecting its fertility and composition. This can have long-term implications for agricultural productivity and plant growth in the affected areas.

Air pollution: The dust particles present in Kota stone slurry can become airborne during handling and disposal. Inhaling these particles can lead to respiratory issues, especially for workers who are directly exposed to the slurry. Prolonged exposure to airborne dust can cause respiratory ailments such as bronchitis, asthma, and other respiratory diseases.

Health hazards: The chemicals used in the processing of Kota stone, which may be present in the slurry, can pose health risks to humans. These chemicals can be toxic or irritants, potentially causing skin irritation, allergic reactions, or other adverse health effects. It is essential to handle and dispose of Kota stone slurry safely to minimize human health hazards.

Materials Used

Cement: A cement is a binder, a material used for construction that sets, hardens, and adheres to other materials to bind them together. In most cases, cement is used to bond sand and gravel (aggregate), not on its own. Mortar for masonry is made from cement mixed with fine aggregate, and concrete is made from cement combined with sand and gravel.

Coarse Aggregates: Aggregate that is mostly retained on a 4.75 mm IS sieve and contains no more finer material than is necessary for the different types of aggregates listed in this standard. Aggregates account for 60–80% of the concrete's volume and 70–85% of its mass. Additionally, aggregate is crucial for concrete's strength, thermal and elastic qualities, volume stability and dimensional stability.

Fine Aggregate: Aggregate that mostly passes the 4.75 mm IS Sieve and only contains the maximum amount of coarser material allowed by Rule 63.

Kota Stone: Located in the Kota district of Rajasthan, India, Kota Stone is a fine-grained variety of Kota limestone. The Ramganj Mandi town and the Kota district both contain a large number of mines. This stone's popularity is mostly due to its greenish-blue and brown colors. Other colors are black, grey, pinkand beige. The stone can be used both inside and outside of buildings, though it is typically used on the exterior.

Granite Waste: Rajasthan, a state located in northern India, is known for its rich reserves of granite. The granite industry in Rajasthan plays a significant role in the state's economy, providing employment opportunities and contributing to revenue generation. However, with the extraction and processing of granite, there is also the issue of granite waste. Granite waste refers to the by-products and leftover materials that are generated during the mining and processing of granite. It includes various types of waste, such as slurry, dust, and small-sized irregular pieces of granite.

Fig. 1. Experimental Materials

Experimental Methodology

For this study, we will produce concrete cubes with varying amounts of coarse and fine aggregate replaced with Kota stone and Granite chips. The replacement percentage of kota stone chips are25%to

100%. First, an experimental examination will be done to determine whether kota stone aggregates were preferable to natural aggregates. An Ordinary Portland Cement (OPC) will used in the control mix for concrete at a weight-to-cement ratio of 0.40 (w/c). Then, concrete mixtures will be made by substituting kota stone aggregates for natural aggregates in control mixes at various percentages.

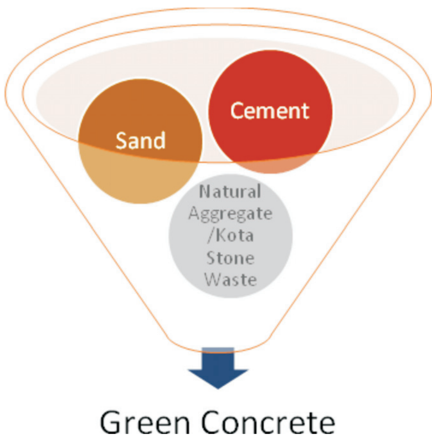

Fig. 2. Experimental Process

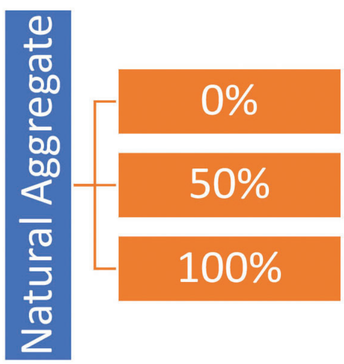

Fig. 3. Kota Stone Waste Replacement

Compressive strength

A crucial characteristic that is carefully examined in practically all research studies is the compressive strength of concrete and cement mortar. In this research article we are partially and fully replacing coarse aggregates with Kota stone chips & calculating the compressive strength of the concrete blocks. Where we are going to test & detect the differences of the Compressive Strength with varying percentage of aggregates replaced. Using the following formula, the compressive strength was resolute from the measured compressive load at failure for (7 and 28 days):

Compressive strength = P/A
Where P = failure load and A = area of cube.

Tensile strength

The tensile strength of concrete is relatively low compared to its compressive strength. Concrete is a brittle material, and its tensile strength is typically only about 10% to 15% of its compressive strength. The average tensile strength of normal concrete ranges from 1.5 to 5 megapascals (MPa), or approximately 217 to 725 pounds per square inch (psi).

Flexural strength

The flexural strength of concrete is typically expressed in terms of stress, measured in megapascals (MPa) or pounds per square inch (psi). The average flexural strength of normal concrete ranges from 3 to 5 MPa (435 to 725 psi), but it can vary depending on factors such as the mix design, curing conditions, and the age of the concrete.

Ultrasonic Pulse Velocity Meter (UPV):

This UPV test is carried out in accordance with the IS: 13311 (Part 1) - 1992 code to assess the behavior (quality) of concrete using the UPV method. For this procedure, timing the passage of an ultrasonic pulse through the tested concrete is necessary. A comparative higher velocity is attained when the quality of

Table 1. Calculation of specific gravity (fine aggregate)

S.No.	Particulars	Test (G)
1	Weight of Pycnometer bottle (W1), g	569 g
2	Weight of Pycnometer + dry soil (W2),g	873g
3	Weight of Pycnometer + soil + water, (W3), g	1784g
4	Weight of Pycnometer + water (W4), g	1601g
5	Calculation of specific gravity, G	2.51

specific gravity of fine aggregate is 2.51.

Table 2. Calculation of specific gravity (natural coarse aggregate)

S.No.	Particulars	Test (G)
1	Weight of Pycnometer bottle (W1), g	583g
2	Weight of Pycnometer + dry natural aggregate (W2), g	1596g
3	Weight of Pycnometer + natural aggregate + water, (W3),g	2269 g
4	Weight of Pycnometer + water (W4), g	1606g
5	Calculation of specific gravity, G	2.89

Specific gravity of natural coarse aggregate is 2.89.

the concrete is high in terms of density, uniformity, homogeneity, etc.

Results and Discussion

Table 3. Calculation of specific gravity (kotastone aggregate)

S.No.	Particulars	Test (G)
1	Weight of Pycnometer bottle (W_1), g	569g
2	Weight of Pycnometer + dry kota stone chips (W_2), g	1568g
3	Weight of Pycnometer + kota stone chips + water, (W_3), g	2224g
4	Weight of Pycnometer + water (W_4), g	1601
5	Calculation of specific gravity, G	2.65

Specific gravity of kotastone aggregate is 2.65.

Table 6. Compressive Strength Result of Concrete Mix Using Kota Stone Waste

Sr. No.	Trial Mix No.	Kota Stone waste as partial replacement of Coarse Aggregates (%)	Compressive Strength (N/mm^2)	
			7 Days	28 Days
1	CC	0	18.54	28.67
2	S1	50	17.54	26.81
3	S2	100	16.25	25.45

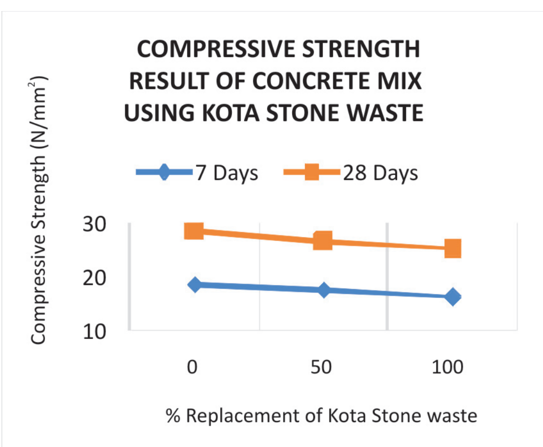

Table 7. Tensile Strength Result of Concrete Mix Using Kota Stone Waste

Sr. No.	Trial Mix No.	Kota Stone waste as partial replacement of Coarse Aggregates (%)	Tensile Strength (N/mm^2)	
			7 Days	28 Days
1	CC	0	1.9	3.8
2	S1	50	1.6	3.6
3	S2	100	1.4	3.2

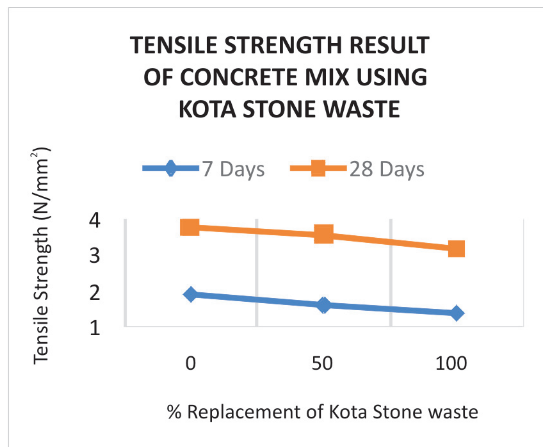

Table 8. Flexural Strength Result of Concrete Mix Using Kota Stone Waste

Sr. No.	Trial Mix No.	Kota Stone waste as partial replacement of Coarse Aggregates (%)	Flexural Strength (N/mm^2)	
			7 Days	28 Days
1	CC	0	2.2	4.1
2	S1	50	1.9	3.4
3	S2	100	1.7	3.1

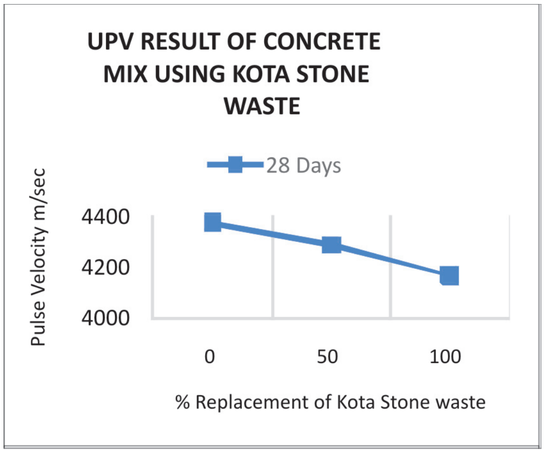

Table 9. UPV Result of Concrete Mix Using Kota Stone Waste

Sr. No.	Trial Mix No.	Kota Stone waste as partial replacement of Coarse Aggregates (%)	Pulse Velocity m/sec
1	CC	0	4375
2	S1	50	4288
3	S2	100	4168

Conclusion

1. It was discovered that there was little difference in the compressive strength of both traditional concrete and Kota stone waste.
2. According to this test, 50% replacement of coarse aggregates with kota stone waste material results in the highest compressive strength.
3. Based on the results of this test, replacing coarse aggregates with kota stone waste gives the lowest compressive strength at 100% replacement.
4. From this test, replacement of coarse aggregates with kota stone waste provides a good UPV Resultat 50% replacement and also shows average result at 100% replacement.
5. Utilizing waste will increase its environmental sensitivity and competence.
6. It could be a safe alternative to other disposal methods for stone refuse.

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