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A Review on Partial Replacement of Cement by Kota Stone Powder

Hammad Ahmad Khan¹, Md. Faiz², Mohsin Khan Agwan³, Kapil Karadia⁴

B.Tech Scholar, Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur, India¹

B.Tech Scholar, Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur, India²

Assistant Professor, Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur, India³

H.O.D., Department of Civil Engineering, Arya College of Engineering and Research Centre, Jaipur, India⁴

ABSTRACT: Kota Stone is a fine-grained variety of limestone, quarried at Kota district, Rajasthan, India. Hundreds of mines are located in or near the town of Ramganj Mandi and in the Kota district. The greenish-blue and brown colours of this **stone** contribute to its popularity. Other colours are black, pink, grey, and beige. During cutting and polishing process, a lot of material remains unused, and this waste may be called as Kota stone cutting and polishing waste. During the process of cutting, in that original stone waste mass is lost by 25% in the form of dust. Accordingly, the amount of mining and processing waste has increased. (3) Recent advances in the concrete technology are aiding in minimizing the use of conventional materials by substituting by-products of various industries and energy sources. A large amount of stone wastes i.e., dust and slurry form both are being originated during natural stone processing and causing serious effects on the environment. The disposal problem of stone waste can be resolved effectively by using waste in construction industries. In present work, Kota stone slurry powder, as a partial replacement to cement was used to study their impact on various properties of the concrete mixtures. Results showed Kota stone slurry powder enhanced the mechanical strength. Kota stone slurry powder found to be the most effective material. In the present investigation, cement has been partially replaced with Kota Stone powder in two different percentage mixes of 7.5% and 12.5% by weight of cement content in concrete for M20 and M25 grade of Concrete. The experimental investigation was carried out as per recommended procedures by relevant codes.

I. INTRODUCTION

Kota Stone is a fine-grained variety of limestone, quarried at **Kota** district, Rajasthan, India. Hundreds of mines are located in or near the town of Ramganj Mandi and in the **Kota** district. The greenish-blue and brown colours of this **stone** contribute to its popularity. Other colours are black, pink, grey, and beige. The present dumping practices have been creating a number of nuisances and problems, including environmental and human health. Scientific disposal systems but with more emphasis on engineering utilization have to be developed simultaneously and as fast as possible. Construction industries can be the main user of marble slurry whether in bulk or minor quantities. The utilization of marble slurry in the manufacturing of bricks, includes full replacement of conventional fine aggregates with marble slurry content.

Use of stone waste in various engineering applications can solve the problem of disposing of stone waste and other purposes. Stone waste can be used in concrete to improve its strength and other durability factors. Stone waste can be used as a partial replacement of cement or replacement of fine aggregate and as a supplementary addition to achieve different properties of concrete. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. There is a great impetus worldwide towards recycling industrial waste by-products and their utilization as renewable. During the process of cutting, in that original stone waste mass is lost by 25% in the form of dust (3) Recycling of stone cutting waste has a positive effect in avoiding the environmental degradation due to the impact of these materials. Environmentally, recycling of the stone cut-ting waste will reduce its impact on the ecosystem, save the natural resources, and reduce CO2 emissions.

Nature has gifted large deposits of stones such as marble, granite and wide variety of limestone. India ranks third in the world in stone production and subsequently in the production of stone slurry. Kota stone is a fine-grained variety of limestone.

So, this waste can be used as a replacement of cement. Thus, this will decrease the cost of construction as less cement would be utilized. In addition to that, Kota stone slurry, which is a waste gets reduced and used. To the best of knowledge of the author, this is the first time where stone cutting waste is used for heavy metal removal. Using of this low cost, recyclable material will reduce the disadvantages of using large quantities of expensive chemical additives that generating large volumes of toxic sludge.

II. LITERATURE REVIEW

Aman Jain et al ^[1] Kota stone waste are available from stone crushing units in abundant amount. The waste obtained is called stone chips. Sieve analysis as per IS Code procedure is performed on this waste and predominant size of waste particles is obtained. This waste so obtained is tested by replacing 5%, 10%, 15% of cement in the concrete. The laboratory test results in compressive strength and Split Tensile strength, seems to indicate that it increases & enhances the mix strength over the conventional mix. Also, higher workability is obtained for more basalt aggregate content mix which reduces the cost of labour.

The laboratory test results in compressive strength and in Split Tensile strength.

Table 1: Compressive Strength test result of M20 concrete mix

Sr. No.	Amount of Kota Stonedust used	Compressive Strength at 28 days (N/mm ²)
1	0%	27.93
2	5%	30.72
3	10%	29.35
4	15%	22.27

Table 2: Compressive Strength test result of M25 concrete mix

Sr. No.	Amount of Kota Stonedust used	Compressive Strength at 28 days (N/mm ²)
1	0%	22.89
2	5%	25.64
3	10%	24.26
4	15%	17.28

Sr. No.	Amount of Kota Stonedust used	Compressive Strength at 28 days (N/mm ²)
1	0%	3.13
2	5%	3.36
3	10%	3.24
4	15%	2.19

Table 4: Split Strength test result of M25 concrete mix

Sr. No.	Amount of Kota Stonedust used	Compressive Strength at 28 days (N/mm ²)
1	0%	3.5
2	5%	3.83
3	10%	3.24
4	15%	2.19

Er. Rahul Jain et al ^[2] researched on Kota stone slurry (KSS) and stated that it can be used as a partial replacement of the cement in this study. The objective of the present study is to determine strength and durability parameters of the concrete containing Kota stone slurry. The experimental programme consists of preparing concrete mixes with two water binder ratios: 0.40 and 0.50 with varying Kota stone slurry percentage as 0, 5, 10, 15, 20 and 25% partially replaced with cement. The Compressive and flexural strength test, pull-off test was performed to evaluate strength and water permeability test, carbonation test and abrasion test were performed to check the durability of concrete mixes. The results indicate that with the increase in Kota stone slurry content, the compressive and flexural strength decreased. The KSS concrete can be used in construction of rigid pavements in low-cost roads, as it has performed better in abrasion.

Jitesh Mehta et al ^[3] Kota stone sludge can be used as a partial replacement of 'Cement' / 'Fine/Coarse Aggregates'. This helps in reducing the cost, saving the energy and has fewer hazards on the environment. The Proper grading results in higher packing, improved strength (Compressive Strength, Tensile Strength, Flexural Strength), greater durability and abrasion resistance. The stone waste can be replaced as 50% by weight of materials which is used for bricks and replacement of OPC by stone waste @30% provides maximum strength.

Sayed Imran Ali et al ^[4] M40 grade concrete is tested due to wider range of applications. GGBFS can be used along with OPC and PPC. Superior durability of structures extending from 50-100 years. The Silka- Plastiment @ 0.7% by weight of cement can be used which is design as per IS 10262: 2009. The slump value increases with increase in GGBFS and decreases with increase in content of KSPS. The replacement of 40% of cement by GGBFS results in merely 1%-3% reduction in CS after 56 days which is not a significant change. For aforementioned mix, replacement of 20% of FA by KSPS also gives similar results. Also, for FS similar results are observed.

In a study conducted by Harshwardhan S.C. et al ^[5], the stone slurry was used in M-25 grade concrete as a substitution of OPC in the proportion of 0, 10, 20, 30, 40, and 50%; the replacement was done by weight of cement. The concrete mixes were tested for workability and strength on conventional concrete. The result showed increased compressive strength up to 30% cement replacement.

Table 5: Details according to % replacement

	0% replacement	30% replacement
W/C	0.040	0.40
Concrete	1.00	0.70
FA	1.01	1.01
CA	2.50	2.50
KS Waste	-	0.30
C-S 28 days N-sq mm	16.22	29.78
Total cost/m ³ (march 2013)	4135.12	3244.18

In a study conducted by Ankit Nilesh Chandra Patel et al ^[6], The particle size of the KSS used was smaller than 90 μm . Mix proportion was of 1:3 by volume. River sand - zone-III as per specifications IS 383: 1970. ACC Brand, Portland Pozzolana Cement (PPC) was used. The cement was substituted in proportions of 0 to 30% with an interval of 5%. 1:3 mortar was used for sample preparation with 0.85 w/c ratio constant for all mixes. The test results show that tensile strength, compressive strength, flexural strength increased up to 10% replacement of cement by KSS, and then it decreased. So, it is adequate to replace cement up to 10% without any loss in strength.

Table 6: Details according to % replacement of KSS

	0% replacement	10% replacement
7 days Compressive strength MPa	3.84	4.17
28 days Compressive strength MPa	8.2	8.58
Flexure strength MPa	2.32	4.12
Tensile strength MPa	0.541	2.50

Kamel Al-Zboon et al ^[7] studied that the FA are replaced by KSW, 26 concrete mixes were prepared by replacing FA with slurry, manufactured sand (MS) and crushed sand. Test results showed that MS which formulated by blending crushed stone waste (85%), and slurry (15%) could lead to their use in concrete as a replacement of fine aggregate. This gives superior strength and reduced permeability, bleeding and void formation within the concrete. Test results suggests that MS (15% slurry + 85% CS) can completely replace river sand in concrete. The compressive strength of concrete increased by 21 %, flexural strength by 18 %, mortar compressive strength by 11 %, and flexural strength by 11.7 %. Slump values of concrete were reduced by 58 %. Such results emphasized the feasibility of reusing slurry sludge in concrete and mortar production.

IV. CONCLUSION

The industry's disposal of the marble/granite/kotastone powder material, consisting of very fine particles, today constitutes to be one of the major environmental problems around the world. Marble / Granite blocks are cut into smaller blocks in order to give them the desired smooth shape. During the cutting process about 25% of the original stone mass is lost. Use of stone waste in various engineering applications can solve the problem of its disposal. Stone waste can be used in concrete to improve its strength and other durability parameters. This can be used as a partial replacement of cement, sand and coarse aggregate maintaining the premium properties of concrete. Use of such materials offer cost reduction, energy savings and superior products with fewer hazards to the environment. Considering the strength criteria, the replacement of cement by Kota Stone powder by 7.50 % is feasible to obtain a maximum strength at 28 days. The higher replacement of Kota Stone Powder does not show large reduction in strength. By adding Kota Stone powder more than 7.50 %, the compressive strength, Flexural Strength and Split Tensile strength decreases. Slump value of Concrete with Kota Stone Powder is higher than Conventional concrete.

Considering two main important properties such as Characteristic compressive Strength and Flexural Strength we can prefer 12.50% from economic point of view, the replacement of cement by Kota Stone powder. From studying all these research paper, it is clear that positive and favorable results are obtained if further research work and study is carried out in this field. And by using locally available wastes like glass waste, marble dust powder, ceramic waste, quarry dust, GGBS, Fly ash, etc. as partial substitution at place of concrete ingredients, it may prove more economical than traditional concrete and question of damping of such waste produced by different industries is also get solved. Ultimate goal is to produce economical and eco-friendly concrete with all desired properties and strength which one obtains by regular concrete ingredients.

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