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Effect of Kota Stone Slurry Powder in Fresh and Hardened Concrete: A Review

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ABSTRACT

Concrete is highly used construction material with cement being its major ingredient. Also, the demand for good quality of concrete is increasing because of the fast-growing urbanization. But there are certain problems associated with the manufacturing of cement. One of the major problems being production of carbon dioxide causing pollution in environment, the manufacturing of cement is quite expensive and it also leads to the depletion of resources. In order to curtail the consumption of cement, it has become inevitable to replace cement by certain amount with substituent materials that are cheaper to produce in order to lower down the financial cost of concrete production by some extent. The review paper, elaborates many properties of concrete by the inclusion of Kota stone slurry after evaluating several research papers. The following paper discusses numerous properties of concrete including workability, compressive strength, split tensile strength, water absorption and modulus of elasticity. The paper demonstrates that when used appropriately, inclusion of Kota stone slurry in concrete had a positive impact on concrete by increasing the strength and durability.

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Keywords

Durability Property;
Kota Stone Slurry;
Mechanical Property;
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Introduction

Cement is an essential construction material[1] since it is widely used as a binder in the making of mortar.[2] Nevertheless, manufacturing of cement results in discharge of greenhouse gases in the environment.[3] According to research conducted by Joseph Davidovit it was elaborated that while producing every ton of cement, about 1 ton of CO_2 is released which is an immense amount contributing in 5% of total man-made CO_2 emission[4] in which India, emits nearly 7% of the total emissions of carbon dioxide.[5] The production of waste is inevitable in the industries[6] but, with the utilization of industrial waste material as a fractional substitution of cement, developing a low carbon footprint system having relatively lesser embodied energy of production is possible.[7-9] Addition of substituent materials will help in sustainable and effective construction of the structures by lowering down the waste that is generated.[10]

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Kota stone is produced after the process of mining when stone sawed is given desired dimension and polish.[11] Mining processes generates considerable waste in which the net Kota stone obtained is 30%.[12] During the processing in gang saws, the chunks of stone create slurry with the Kota stone solid to produce Kota stone slurry.[13] Kota stone is a fine-grained waste having non-slipping surface and amorphous texture so it is also known as flaggy limestone.[14] Kota stone is available in many shades making it fit for the commercial and decorative purposes.[15] The utilization of Kota stone waste in concrete will significantly reduce the environmental effluence by solving problems associated with the unmanageable disposal of fine slurry powder in the soil.[16-17] The consumption of cement will also be reduced.[18]

In last two decades the stone sector has increased rapidly with new technologies due to large infrastructural developments.[19-20] In India the annual production of stone is very large occupying third position in the world [21] and Rajasthan shares about 50% of its productions.[22] Usage of Kota stone slurry has increased over the few years as it caters to need of sustainable and economic construction.[23] Also, sources of sand have started getting exhausted which there by creates a need of the stone waste to be utilized as a partial replacement of fine aggregate in the manufacturing of concrete.[24] When used correctly the stone slurry have an undeniably positive impact on concrete by enhancing the mechanical and durability properties of the mix[25-27]

Impact of Kota Stone Slurry on The Environment and Humans

The mismanagement and improper planning of dumping waste produced during mining have led to several environmental issues by disturbing flora and fauna.[28] Mining waste when discarded in dry streams are carried by surface runoff[29] causing the contamination of water bodies by increasing the amount of total dissolved solids and sulphates.[30] When the waste is dumped on land, it has a detrimental impact on the land as it makes the soil infertile[31] and causes an increase in alkalinity.[32] Long-term deposition of waste on land causes the blocking of fine slurry particles while drifting water in aquifers[33] thereby, affecting the availability of ground water.[34] Agglomeration of the stone slurry also spoils aesthetic appearance of the place where it is been disposed.[35-36] Excessive dumping of the mining waste also causes a detrimental impact on the health of people.[37-38] Also, from economic point of view, there are heavy operational costs involved in the management and treatment of generated waste which will thereby be reduced by including them in the concrete production.[39]

Impact of Stone Slurry on the Properties of Concrete

When stone slurry is incorporated in concrete it helps in improving durability by reducing the size as well as volume of pores developed.[40-41] Increment in strength was also noted by various researchers.[42-44] Chouhan *et al.*[45] evaluated the performance of substituting sand with Kota stone slurry by conducting various tests. It was concluded that sand could be substituted by Kota stone slurry up to 40% of replacement. Jain *et al*.[46] examined the performance of Kota stone slurry as partial replacement of cement in the ratio of 0% to 25%. Tests were conducted in order to ascertain the mechanical and durability properties of mixes. Results showed that with increment in Kota stone slurry in concrete there was a reduction in compressive and flexural strength but the mixes displayed better resistance to abrasion making them suitable to be used as flooring and pavement material. Al-Akhras *et al*.[47] analysed that with the enhancement of burnt stone slurry there was an improvement in the strength of mortar but the setting time as well as workability of mortar was reduced.

Almeida *et al*.[48] utilised stone slurry for replacing fine aggregates in the mixture of concrete. The level of sand substitution selected were 0%, 5%, 10%, 15%, 20%, 34%, 67%, 100%. Results showed that substitution of 5% stone slurry led to higher compressive strength, high modulus of elasticity and greater split tensile strength. Substitution level up to 20% was feasible without influencing the mechanical properties of concrete mixture. Gautam *et al*.[49] assessed the effect of replacing aggregates in the sub- base course by Kota stone slurry waste. The performance was evaluated by modified proctor test and optimum dry density. Results exhibited that Kota stone slurry could be utilized effectively as it satisfied all the requirements. Rana *et al*.[50] determined the appropriateness of Kota stone slurry as a replacement of river sand and it was

concluded that by substituting sand with Kota stone, the resultant mixture had greater strength with lesser porosity and bleeding.

Omar *et al*.[51] supported various experiments in to determine the influence of replacing fine aggregates with stone slurry. The proportion of replacement selected were 25%, 50% and 75%. It was concluded that the strength of concrete mix was increased up to replacement level of 50%. Lakhani and Tomar[52] studied the consequence of replacing fine aggregates with the slurry of Kota stone for manufacturing the tiles of floor. Results indicated that stone waste could be replaced up to 25%. Basu *et al*.[53] assessed the feasibility of including stone slurry in self-compacting concrete. Mixes were prepared with 6 percentages as a fractional replacement of cement. It was observed that increase in the content of stone slurry led to better resistance against freeze and thaw and porosity of the concrete mix got reduced. The results showed that 15% replacement of stone slurry was suitable for concrete applications.

Many researchers have studied the mechanism of corrosion and also the preventions of controlling corrosion.[54- 57] Various studies have implied that corrosion in concrete structure was mainly caused due the development of cracks and the rate of corrosion increased with an increase in the width of cracks.[58-61] By the assimilation of stone slurry in the concrete mix, microstructure of the concrete densified[62-63] thereby, leading to a substantial reduction in the pore size and volume.[64]

Li and Kwan[65] described that addition of stone slurry in concrete substantially primed to an increment in the strength of samples and helped in reducing the shrinkage and amount of heat that was generated. Kumar & Prasad[66] also reported that durability of the resultant concrete mix under the activity of HCl and H_2SO_4 at 5% concentration got improved with the integration of stone slurry. Both mechanical as well as durability properties of concrete were enhanced with the inclusion of stone slurry in concrete according to Dobiszewska[67] and Shukla *et al.*[68] Devi *et al*.[69] estimated the consistency and compressive strength of the mortar having stone slurry as cement replacement in the ratio of 5%, 7.5% and 10%. Results concluded that the strength and consistency of the paste got increased. Almeida *et al.*[70] used the slurry of stone in order to investigate its feasibility in concrete of high performance as a substituent of fine aggregates. It was concluded that 16% was the optimum amount of replacement in the concrete mix. Alzboon and Mahasneh[71] concluded that slurry sludge up to replacement of 25% obtained successful results in terms of strength and slump. Arif *et al.*[72] examined the performance of replacing fine and coarse aggregates with the slurry of stone in the ratio of 0%, 5%, 10%, 15%, 20%, 25% and 30%. It was reported that water penetration and risk of sulphate attack got reduced with the increment of stone slurry.

Physical Properties of Kota Stone Powder

Kota stone is predominantly a sedimentary rock which is obtained in various textures and colours. The deposits of stone are stratified and are spilt all along well-formed weak planes which facilitates well textured and smooth homogenous panels of stone of different thickness.

Fig.1: Kota stone slurry

Table 1: Physical characteristics of Kota stone slurry

Authors	Water Absorption (%)	Colour	Specific Gravity
Chouhan *et al*[73]	7.23	White	2.59
Khatti *et al*[74]	15.6	Dirty Grey	2.35
Gautam *et al*[49]	23	White	2.81

Kota stone is a soft stone having hardness between 3-4 (Mohr's scale). It has lower porosity and great water-resistant attribute making it an ideal material to be used in the process of constructing concrete structures.

Table 2: Chemical composition of Kota stone slurry

Authors	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)
Chouhan *et al*[73]	23.5	3.10	1.94	37.85
Lakhani & Tomar[52]	22.69	3.26	2.72	36.32
Hiren & Pitroda[75]	26.67	2.20	-	38.86

Chemical Composition of Kota Stone Powder

Amount of by-product generated from the flaggy limestone industries during the processing of stones nearly reaches around 10-12 million tonnes per year. A major portion of flaggy limestone consists of water and nearly 10% of flaggy limestone powder. Thus, after looking at a huge amount of waste generation there is prodigious need of recycling the generated stone waste in order to facilitate sustainable and economic construction of structures.

Properties Of Fresh Concrete

Fresh concrete properties are mainly dependent on the workability as shown below:

Workability

Workability that is property of concrete by virtue of which it has tendency to flow is determined by various tests. Ashish[76] assessed the workability of M25 and M45 grade of concrete by fluctuating the percentage of slurry powder as a replacement of cement in the ratios of 0%, 2.5%, 5%, 7.5%, 10% and 15%. Findings suggested that with the proliferation in content of stone slurry, workability of the mixture got reduced. For M25 grade of concrete, the compaction factor diverged from 0.73 to 0.84 for the two mix proportions as shown in Fig. 1. While, the compaction factor for M45 grade diversified from 0.83 to 0.93 for the proportions as shown in Fig. 2.

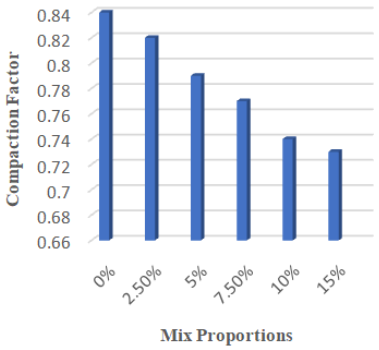

Fig. 2: Compaction factor of M^{25} grade[76]

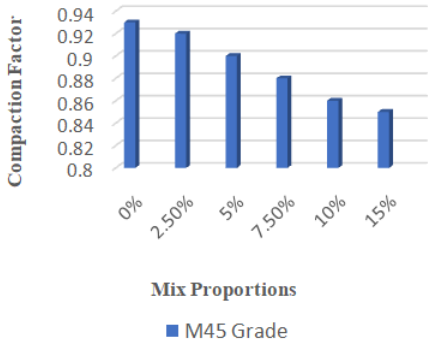

Fig. 3: Compaction factor of M^{45} grade[76]

Table 3: Variation of slump with blast furnace slag and Kota stone slurry[77]

Sr.no.	Blast furnace slag	Kota stone powder		
		0%	10%	15%
1.	30%	66	63	62
2.	40%	69	65	64

Khandelwal *et al.*[77] also determined the workability of concrete mix prepared with 30% and 40% of cement replacement by blast furnace slag whereas, 10% and 15% of fine aggregate replacement by the slurry of Kota stone. Conclusions revealed that with an increase in blast furnace slag, workability got increased but, contrasting results were observed for Kota stone powder as it reduced the slump value with its increment. The outcomes are shown in Table 3.

Hardened Properties

The properties of hardened concrete are explained below on the basis of strength and performance under different loads. The main properties of hardened concrete are listed below:

Table 4: Compressive strength test sequelof M25 grade[78]

Concreterepla -cement (%)	Compressive strength at 7 days [N/mm²]	Compressive strength at 14 days [N/mm²]	Compressive strength at 28 days [N/mm²]
10%	25.48	32.89	34.67
20%	26.67	33.78	35.41
30%	16.22	29.19	29.78
40%	15.85	17.78	22.07
50%	11.41	16.44	16.59

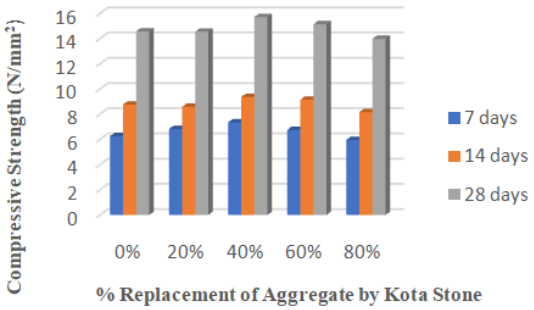

Fig. 4: Compressive strength of M30grade[75]

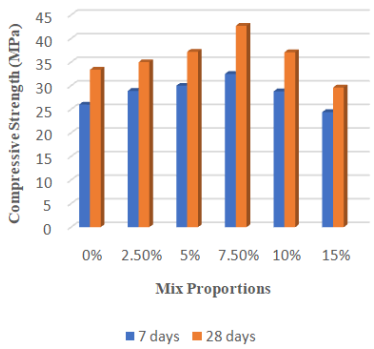

Fig. 5: Compressive strengthof M25 grade[79]

Compressive Strength

It is explained as capacity of concrete structure to endure the cracks and deflection in compression. Strength in compression of the concrete mix incorporating stone slurry was examined by Patel and Pitroda[78] with 10%, 20%, 30%, 40% and 50% replacement levels. Conclusions were made that mix containing 20% substitution had the maximum strength and after 30% replacement the strength reduced eventually as shown in Table 4.

Hiren and Pitroda[75] performed investigation for determining the compressive strength variation of concrete mix by the inclusion of stone slurry in the ratio of 0%, 20%, 40%, 60% and 80% as a substitute of grit respectively. It was revealed that compressive strength at 40% replacement level had the maximum strength which was around 7.75% greater than the normal mix. With further increase in the concentration of stone slurry beyond 40% the compressive strength of mix appeared to reduce as depicted in Fig. 3.

Table 5: Compressive strength test sequel of M30 grade[75]

Concrete replacement (%)	Compressive strength at 7 days [N/mm²]	Compressive strength at 14 days [N/mm²]	Compressive strength at 28 days [N/mm²]
0%	6.25	8.76	14.57
20%	6.82	8.58	14.54
40%	7.34	9.35	15.7
60%	6.74	9.14	15.13
80%	5.95	8.16	13.97

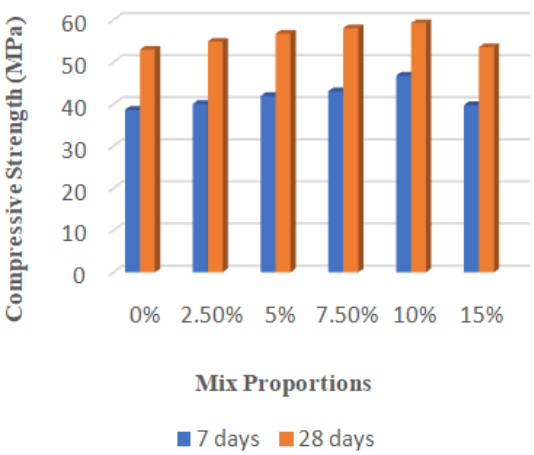

Fig. 6: Compressive strengthof M45 grade[79]

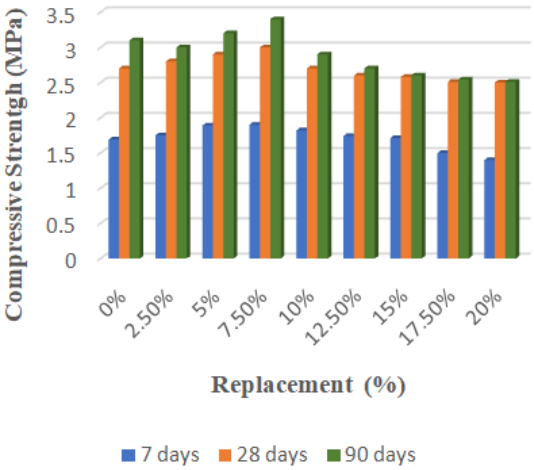

Fig. 7: Compressive strength of M25 grade[73]

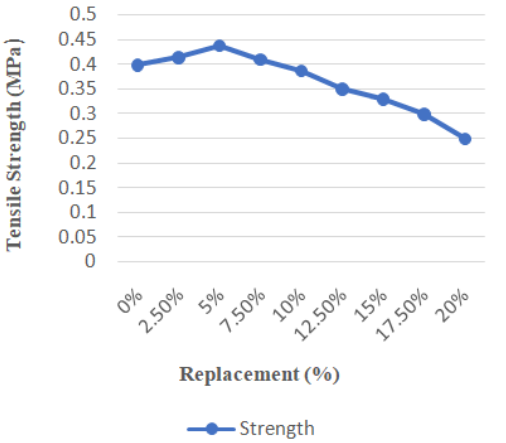

Fig. 8: Tensile strength results of M25 grade[73]

Khodabakhshian *et al.*[79] performed an experimental study for determining the strength of concrete in compression by incorporating stone slurry. It was concluded that for M25 grade of concrete, the strength got improved up to 7.5% substitution and then after it reduced significantly. Whereas, for M45 the strength increment was up till 10% and after this there was a considerable reduction in strength. Fig. 4 and Fig. 5 represent the results of study. Chouhan *et al.*[73] performed a test by using stone slurry as a partial substitution of cement in concrete mix. It was revealed that the samples containing Kota stone slurry exhibited an increment in the strength till 7.5% of substitution and after this level the strength got reduced dramatically as minimum strength was observed at 20% replacement level as shown in Fig. 6.

Ability of concrete to with stand tensile stresses that are caused by the application of load is termed as its tensile strength.

Chouhan *et al.*[73] deliberated the tensile strength of concrete by adding Kota stone slurry as a partial substitution of cement. Supreme strength of 0.437 MPa was observed at 5% and the lowest of 0.25 MPa was observed at 20%. Results of their finding are represented in Fig. 7.

Khodabakhshian *et al.*[79] carried out studies for determining the tensile strength of M25 and M45 grade of concrete. It was concluded that the tensile strength of the mix was higher than the control mixes up to 10% after this there was a momentous decrease in the strength.

Kumar and Saini[80] inspected the mechanical properties of concrete mix comprising of stone slurry as a replacement of cement in partial amount. Cement was replaced in the proportion of 0%, 25%, 50%, 75% and 100%. Conclusions were made that the strength enhanced till 25% replacement whereas, at 100% replacement the strength became lower than control mix as shown in Fig. 8.

Electrical Resistivity

Ability of concrete to withstand transferring of the ions that are exposed to electrical field is termed as electrical resistivity.

Table 6: Electrical resistivity test results under different chemical exposure[25]

% Replacement	Electrical resistivity (kΩ-cm)			
	H_2O	NaCl	Na_2SO_4	NaCl+Na_2SO_4
0%	125.10	127.10	129.20	128.54
25%	142.78	151.90	155.23	153.76
50%	149.98	152.99	159.56	156.43

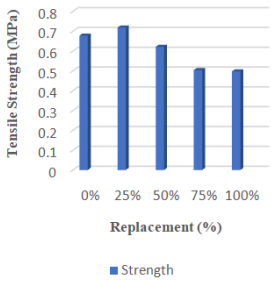

Fig. 9: Tensile strength results of M30 grade[80]

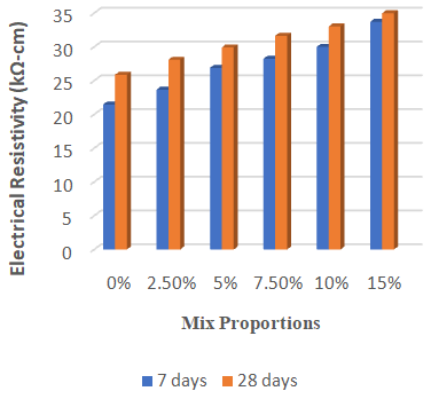

Fig. 10: Electrical resistivity of M25 grade[79]

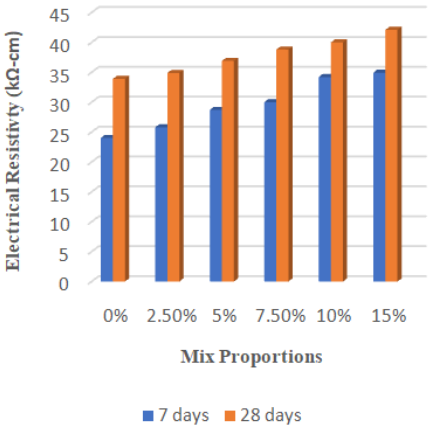

Fig. 11: Electrical resistivityof M45 grade[79]

Singh *et al.*[25] carried out an investigation under different chemical exposure conditions for determining the electrical resistivity of concrete mix containing river sand been replaced by the stone slurry having substitution level of 25% and 50%. It was discovered that at 25% the electrical resistivity increased by 7.15% whereas at 50% substitution the increase was of 3.98%. Outcomes of their findings are in Table 5.

Khodabakhshian *et al.*[79] experimented to assess the electrical resistivity of stone slurry that incorporated M25 and M45 concrete mix. It was concluded that by increasing the content of stone slurry, the value of electrical resistivity got increased. For M25 grade maximum increase in the percentage of resistivity was 34.72% as shown in Fig. 9 while for M45 the increase was of 31.10% as represented in Fig 10. The reason being, with the inclusion of stone slurry the porosity of the mix increased thereby causing the filling up of pores which resulted in a dense structure.

Water Absorption

It is referred as increase in the weight as a percentage of original weight. Chouhan *et al.*[73] partially substituted cement with the slurry of Kota stone. It was observed that maximum value of absorption was at 20% substitution level. This was because of the large water absorbing capacity of the slurry of stone. Though up to 10% substitution level slight variations of increment were observed. Fig. 11 depicts the test results.

Kumar and Saini[80] demonstrated an investigational experiment in order to determine durability of concrete mix containing slurry of Kota stone as a fragmentary substitution of fine aggregates in 0%, 25%, 50%, 75% and 100% replacement level. It was concluded that increase in the content of stone slurry,

increased the percentage of water absorption with a considerable amount as given in Fig. 12.

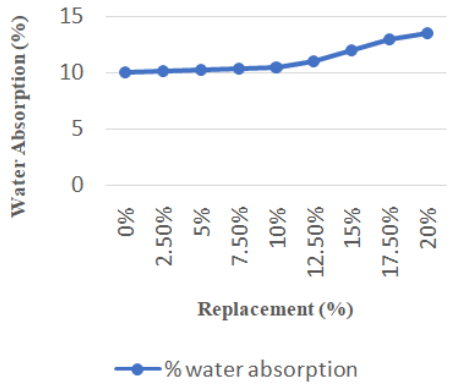

Fig. 12: Water absorption results of M25 grade[73]

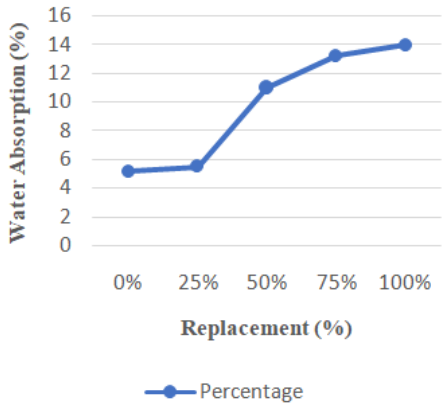

Fig. 13: Water absorption results of M30 grade[80]

Chouhan *et al.*[81] studied the behaviour of concrete incorporating stone slurry with 0%, 20%, 40% and 60% level of substitution. It was discovered that with an increment in the content of stone slurry, water absorption got increased and it was highest at maximum replacement level of 60% which was about 37.5% more than the normal control mix.

Mehta and Pitroda[82] analysed the effect of replacing marble brick with Kota stone powder in 0%, 20%, 40% 60% and 80% levels of replacement. It was noticed that water absorption decreased progressively after the substitution of 20 % and 40% Kota stone powder, further with an increment in the addition of Kota stone powder the percentage of water absorption increased eventually.

Concluding Remarks

By analysing the researcher's works on the utilization of Kota stone in concrete production, the following observations could be drawn:

- The workability of concrete decreases by increasing the content of Kota stone slurry. The decrease in workability is due to higher surface of particles of stone slurry.
- There is an increment in the compressive strength by increasing the percentage of Kota stone slurry till 7.5% after this the strength gradually decreased. Here initial strength increment is because of the filling characteristics of stone slurry but, the reduction is due to loss of the cementitious particles.
- Split tensile strength of concrete having Kota stone slurry increases on increasing the percentage of substitution of cement. At 10% replacement, the tensile strength is maximum.
- Water absorption of the concrete mix increases by increasing the Kota stone slurry till 20%. The reason being, better water absorption capacity of the stone slurry.
- Increase in substitution percentage of Kota stone slurry also led to an increment in the electrical resistivity of the concrete mix because increment of stone slurry, increases the porosity of mix.
- With the replacement of constituents of concrete with slurry of Kota stone, the overall construction cost reduces and it also led to an increase in mechanical as well as durability properties of mix.
- The biggest problem of waste disposal would be solved by incorporating waste produced in industries for making concrete thereby leading to sustainable construction as these materials like blast furnace slag and Kota stone slurry are already produced and will be discarded very less.

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Conflict of Interests

Authors have detected that no competing interests exist.

References

1. Malhotra, V. M. (2010). Global warming, and role of supplementary cementing materials and superplasticisers in reducing greenhouse gas emissions from the manufacturing of portland cement. *International Journal of Structural Engineering,* 1(2), 116-130.
2. Gupta, T., Kothari, S., Siddique, S., Sharma, R. K., & Chaudhary, S. (2019). Influence of stone processing dust on mechanical, durability and sustainability of concrete. *Construction and Building Materials,* 223, 918-927.
3. Mohamed, G., & Djamila, B. (2018). Physical, mechanical and thermal properties of Crushed Sand Concrete containing Rubber Waste. In *MATEC Web of Conferences* (Vol. 149, p. 01076). EDP Sciences.
4. Davidovits, J. (1994). Global warming impact on the cement and aggregates industries. *World resource review,* 6(2), 263-278.
5. Chouhan, D. S., Agrawal, Y., Gupta, T., & Sharma, R. K. (2017). Utilization of Granite Slurry Waste in Concrete: A. *Indian Journal of Science and Technology,* 10, 6.
6. Agrawal, Y., Siddique, S., Sharma, R. K., & Gupta, T. (2021). Valorization of granite production dust in development of rich and lean cement mortar. *Journal of Material Cycles and Waste Management,* 23(2), 686-698.
7. Cheah, C. B., & Ramli, M. (2012). Mechanical strength, durability and drying shrinkage of structural mortar containing HCWA as partial replacement of cement. *Construction and Building Materials,* 30, 320-329.
8. Chouhan, D. S., Gupta, T., & Sharma, R. K. (2019). Fresh and hardened properties of granite slurry concrete incorporating metakaolin. In *UKERI concrete congress.*
9. SHARMA, R. K., Gupta, T., & SHARMA, S. (2016). Assessment of mechanical properties of concrete containing granite slurry waste. *International Journal of Engineering,* 29(5), 599-605.
10. Agrawal, Y., Gupta, T., Siddique, S., & Sharma, R. K. (2021). Potential of dolomite industrial waste as construction material: a review. *Innovative Infrastructure Solutions,* 6(4), 1-15.
11. Mohamed, G., & Djamila, B. (2018). Physical and mechanical properties of cement mortar made with brick waste. In *MATEC Web of Conferences* (Vol. 149, p. 01077). EDP Sciences.
12. Al-Zboon, K., & Al-Zou'by, J. (2015). Recycling of stone cutting slurry in concrete mixes. *Journal of Material Cycles and Waste Management,* 17(2), 324-335.
13. Hussain, A., Lakhani, R., Prabhakar, V., & Shams, R. An experimental study on lightweight concrete using kota stone slurry waste.
14. Devi, K., Saini, B., & Aggarwal, P. (2019). Utilization of Kota stone slurry powder and accelerators in concrete. *Computers and Concrete, 23*(3), 189-201.
15. Sharma, P. K., Khandelwal, M., & Singh, T. N. (2007). Variation on physico-mechanical properties of Kota stone under different watery environments. *Building and Environment,* 42(12), 4117-4123.
16. Tak, D., Sharma, J. K., & Grover, K. S.

(2021). Use of Kota stone powder to improve engineering properties of black cotton soil. In *Problematic Soils and Geoenvironmental Concerns* (pp. 113-126). Springer, Singapore.

17. Jain, A., & Majumder, R. (2016). Strength, permeability and carbonation properties of concrete containing kota stone slurry. SSRG *International Journal of Civil Engineering,* 3(6), 1-8.
18. Guendouz, M., Debieb, F., Boukendakdji, O., Kadri, E. H., Bentchikou, M., & Soualhi, H. (2016). Use of plastic waste in sand concrete. *J. Mater. Environ. Sci,* 7(2), 382-389.
19. Guendouz, M., Boukhelkhal, D., Bourdot, A., Babachikh, O., & Hamadouche, A. (2020). The Effect of Ceramic Wastes on Physical and Mechanical Properties of Eco-Friendly Flowable Sand Concrete. In *Advanced Ceramic Materials.* IntechOpen.
20. Kota, S. K., & Rama, J. K. (2021). Impact of locally available sustainable materials on the overall economy of the construction sector–A review. *Materials Today: Proceedings,* 43, 1103-1109.
21. Lakhani, R., Kumar, R., & Tomar, P. (2014). Utilization of Stone Waste in the Development of Value-Added Products: A State-of-the-Art Review. *Journal of Engineering Science & Technology Review,* 7(3).
22. Boukhelkhal, D., Guendouz, M., Bourdot, A., Cheriet, H., & Messaoudi, K. (2021). Elaboration of bio-based building materials made from recycled olive core. *MRS Energy & Sustainability,* 8(2), 98-109.
23. Ali, S. I., Kumar, R., & Yadav, M. K. (2018). An Experimental Investigation on Concrete Containing Ground Granulated Blast Furnace Slag and Kota Stone Powder Slurry. *Int. Res. J. Eng. Technol,* 5(4), 2382-2384.
24. Guendouz, M., Boukhelkhal, D., & Bourdot, A. (2021). Recycling of Floor Tile Waste as Fine Aggregate in Flowable Sand Concrete. In *Advances in Green Energies and Materials Technology* (pp. 223-229). Springer, Singapore.
25. Singh, M., Saini, B., & Chalak, H. D. (2020). Long term evaluation of engineered cementitious composite containing stone slurry powder. *Construction and Building Materials,* 264, 120183.
26. Febin, G. K., Abhirami, A., Vineetha, A. K., Manisha, V., Ramkrishnan, R., Sathyan, D., & Mini, K. M. (2019). Strength and durability properties of quarry dust powder incorporated concrete blocks. *Construction and Building Materials,* 228, 116793.
27. Mohankumar, G., & Sudharsan, S. International journal of engineering sciences & research technology study on the replacement of cement and fine aggregate with quarry dust.
28. Mosaferi, M., Dianat, I., Khatibi, M. S., Mansour, S. N., Fahiminia, M., & Hashemi, A. A. (2014). Review of environmental aspects and waste management of stone cutting and fabrication industries. *Journal of Material Cycles and Waste Management,* 16(4), 721-730.
29. Al-Joulani, N. (2014). Utilization of stone slurry powder in production of artificial stones. *Research Journal in Engineering and Applied Sciences,* 3(4).
30. Jangid, A. K., Khatti, J., & Bindlish, A. (2018). Stabilization of black cotton soil by 15% Kota stone slurry with wooden saw dust. *Int J Adv Res Sci Eng,* 7(2), 108-114.
31. Nasserdine, K., Mimi, Z., Bevan, B., & Elian, B. (2009). Environmental management of the stone cutting industry. *Journal of environmental management,* 90(1), 466-470.
32. Jain, S., Mathur, R., Chandrawat, M. P. S., & Sudan, P. Use of Kota stone waste to ameliorate the soil fertility and to alleviate environmental hazards.
33. Karaca, Z., Pekin, A., & Deliormanlı, A. H. (2012). Classification of dimension stone wastes. *Environmental Science and Pollution Research,* 19(6), 2354-2362.
34. Gunasekaran, S. Kota Stone Waste: A Threat to Environment.
35. Almeida, N., Branco, F., de Brito, J., & Santos, J. R. (2007). High-performance concrete with recycled stone slurry. *Cement and Concrete Research,* 37(2), 210-220.
36. Sarami, N., & Mahdavian, L. (2016). Comparison of artificial stone made from sludge stone with travertine stone waste of stone cutting factory. In *International Journal of Engineering Research in Africa* (Vol. 23, pp. 64-71). Trans Tech Publications Ltd.
37. Al-Akhras, N. M., Ababneh, A., & Alaraji, W. A. (2010). Using burnt stone slurry in mortar

mixes. *Construction and Building Materials,* 24(12), 2658-2663.

38. Mosaferi, M., Dianat, I., Khatibi, M. S., Mansour, S. N., Fahiminia, M., & Hashemi, A. A. (2014). Review of environmental aspects and waste management of stone cutting and fabrication industries. *Journal of Material Cycles and Waste Management,* 16(4), 721-730.
39. Zichella, L., Dino, G. A., Bellopede, R., Marini, P., Padoan, E., & Passarella, I. (2020). Environmental impacts, management and potential recovery of residual sludge from the stone industry: The piedmont case. *Resources Policy,* 65, 101562.
40. Rana, A., Kalla, P., & Csetenyi, L. J. (2017). Recycling of dimension limestone industry waste in concrete. *International Journal of Mining, Reclamation and Environment, 31*(4), 231-250.
41. Kumar, L., Thanappan, S., Mekonnen, E., Mulugeta, D., & Chala, G. (2021). Effect of fly ash and sand stone slurry on mechanical properties of concrete materials. *Materials Today: Proceedings, 45,* 2878-2882.
42. Gupta, R., Choudhary, R., Jain, A., Yadav, R., & Nagar, R. (2021). Performance assessment of high strength concrete comprising marble cutting waste and fly ash. Materials Today: Proceedings, 42, 572-577.
43. Mittri, S. H. M., Vieira, G. L., Guignone, G. C., Degen, M. K., Teles, C. R., & Zulcão, R. (2018). Utilisation of heat-treated ornamental stone processing waste as an addition to concretes to improve compressive strength and reduce chloride ion penetration. *Construction and Building Materials, 188,* 444-455.
44. Siddique, S., Jang, J. G., & Gupta, T. (2021). Developing marble slurry as supplementary cementitious material through calcination: Strength and microstructure study. *Construction and Building Materials, 293,* 123474.
45. Chouhan, H. S., Kalla, P., Nagar, R., Gautam, P. K., & Arora, A. N. (2020). Investigating use of dimensional limestone slurry waste as fine aggregate in mortar. *Environment, Development and Sustainability, 22*(3), 2223-2245.
46. Jain, A., & Majumder, R. (2016). Strength, permeability and carbonation properties of concrete containing kota stone slurry. *SSRG International Journal of Civil Engineering, 3*(6), 1-8.
47. Al-Akhras, N. M., Ababneh, A., & Alaraji, W. A. (2010). Using burnt stone slurry in mortar mixes. *Construction and Building Materials, 24*(12), 2658-2663.
48. Almeida, N., Branco, F., & Santos, J. R. (2007). Recycling of stone slurry in industrial activities: Application to concrete mixtures. *Building and Environment, 42*(2), 810-819.
49. Gautam, P. K., Patidar, P., Kalla, P., Jethoo, A. S., & Harshwardhan, S. C. (2017). Use of Kota stone cutting and quarry waste as subbase material. *Interdisciplinary Environmental Review,* 18(2), 93-100.
50. Rana, A., Kalla, P., & Csetenyi, L. J. (2017). Recycling of dimension limestone industry waste in concrete. *International Journal of Mining, Reclamation and Environment, 31*(4), 231-250.
51. Omar, O. M., Abd Elhameed, G. D., Sherif, M. A., & Mohamadien, H. A. (2012). Influence of limestone waste as partial replacement material for sand and marble powder in concrete properties. *HBRC Journal,* 8(3), 193-203.
52. Lakhani, R., & Tomar, P. (2014). Development of flooring tiles from Kota stone waste and study of their physical properties.
53. Basu, P., Thomas, B. S., Gupta, R. C., & Agrawal, V. (2021). Properties of sustainable self-compacting concrete incorporating discarded sandstone slurry. *Journal of Cleaner Production,* 281, 125313.
54. Ahmad, S. (2003). Reinforcement corrosion in concrete structures, its monitoring and service life prediction—a review. *Cement and concrete composites,* 25(4-5), 459-471.
55. Isgor, O. B., & Razaqpur, A. G. (2006). Modelling steel corrosion in concrete structures. *Materials and Structures,* 39(3), 291-302.
56. Sanz, B., Planas, J., & Sancho, J. M. (2015). A closer look to the mechanical behaviour of the oxide layer in concrete reinforcement corrosion. *International Journal of Solids and Structures, 62,* 256-268.
57. Michel, A., Otieno, M., Stang, H., & Geiker, M. R. (2016). Propagation of steel corrosion in concrete: Experimental and numerical

investigations. *Cement and Concrete Composites, 70,* 171-182.

58. Menaka, R., & Subhashini, S. (2016). Chitosan Schiff base as eco-friendly inhibitor for mild steel corrosion in 1 M HCl. *Journal of adhesion science and Technology, 30*(15), 1622-1640.
59. Tran, K. K., Nakamura, H., Kawamura, K., & Kunieda, M. (2011). Analysis of crack propagation due to rebar corrosion using RBSM. *Cement and Concrete Composites, 33*(9), 906-917.
60. Du, F., Jin, Z., She, W., Xiong, C., Feng, G., & Fan, J. (2020). Chloride ions migration and induced reinforcement corrosion in concrete with cracks: a comparative study of current acceleration and natural marine exposure. *Construction and Building Materials, 263,* 120099.
61. Khan, I., François, R., & Castel, A. (2014). Prediction of reinforcement corrosion using corrosion induced cracks width in corroded reinforced concrete beams. *Cement and concrete research,* 56, 84-96.
62. Sabirzianov, R. R., Agzamov, F. A., & Tokunova, E. F. (2019). Increasing the durability and corrosion protection of cement stone in aggressive media. In *Youth technical sessions proceedings* (pp. 352-358). CRC Press.
63. Cheah, C. B., Lim, J. S., & Ramli, M. B. (2019). The mechanical strength and durability properties of ternary blended cementitious composites containing granite quarry dust (GQD) as natural sand replacement. *Construction and Building Materials,* 197, 291-306.
64. Vardhan, K., Siddique, R., & Goyal, S. (2019). Strength, permeation and micro-structural characteristics of concrete incorporating waste marble. *Construction and Building Materials,* 203, 45-55.
65. Li, L. G., Huang, Z. H., Tan, Y. P., Kwan, A. K. H., & Liu, F. (2018). Use of marble dust as paste replacement for recycling waste and improving durability and dimensional stability of mortar. *Construction and building materials,* 166, 423-432.
66. Kumar, V. P., & Prasad, D. R. (2019). Influence of supplementary cementitious materials on strength and durability characteristics of concrete. *Advances in concrete construction,* 7(2), 75.
67. Dobiszewska, M. (2017). Waste materials used in making mortar and concrete. *J. Mater. Educ,* 39(5-6), 133-156.
68. Shukla, A., Gupta, N., & Gupta, A. (2020). Development of green concrete using waste marble dust. *Materials Today: Proceedings, 26,* 2590-2594.
69. Devi, K., Saini, B., & Aggarwal, P. (2018, November). Combined use of accelerators and stone slurry powder in cement mortar. In I*nternational Conference on Sustainable Waste Management through Design* (pp. 202-209). Springer, Cham.
70. Almeida, N., Branco, F., de Brito, J., & Santos, J. R. (2007). High-performance concrete with recycled stone slurry. *Cement and Concrete Research,* 37(2), 210-220.
71. Alzboon, K. K., & Mahasneh, K. N. (2009). Effect of using stone cutting waste on the compression strength and slump characteristics of concrete. *International Journal of Environmental Science and Engineering,* 1(4), 167-172.
72. Arif, M., Gupta, V., Choudhary, H., Kumar, S., & Basu, P. (2018). Performance evaluation of cement concrete containing sandstone slurry. *Construction and Building Materials,* 184, 432-439.
73. Chouhan, H. S., Chouhan, R. S., Kalla, P., Nagar, R., & Gautam, P. K. (2021). Effect of Kota stone slurry on strength properties of cement mortar mixes. *Materials Today: Proceedings, 44,* 4557-4562.
74. Jangid, A. K., Khatti, J., & Bindlish, A. (2018). Stabilization of black cotton soil by 15% Kota stone slurry with Recron 3s fibre. *Int J Adv Res Sci Eng, 7*(2), 102-107.
75. Ramani Hiren, D., & Pitroda, D. J. Experimental Investigation on Replacement of Aggregates by Kota Stone Chips in Solid Concrete Block.
76. Ashish, D. K. (2018). Feasibility of waste marble powder in concrete as partial substitution of cement and sand amalgam for sustainable growth. *Journal of Building Engineering,* 15, 236-242.
77. Moond, A., Khandelwal, N., & Ali, S. I. (2019). An Experimental Investigation on Concrete Containing Meta kaolin and Kota Stone Powder.

78. Patel, A. N., & Pitroda, J. (2013). Stone waste in India for concrete with value creation opportunities. *International Journal of Latest Trends in Engineering and Technology, 2*(2), 113-120.
79. Khodabakhshian, A., De Brito, J., Ghalehnovi, M., & Shamsabadi, E. A. (2018). Mechanical, environmental and economic performance of structural concrete containing silica fume and marble industry waste powder. *Construction and Building Materials, 169,* 237-251.
80. Kumar, E. V., & Saini, E. M. Affect on mechanical properties of Concrete by Using Recycled Coarse Aggregates. *Pan,* 75, 0-13.
81. Chouhan, H. S., Kalla, P., Nagar, R., & Gautam, P. K. (2019). Gainful utilization of dimensional limestone waste as fine aggregate in cement mortar mixes. *Construction and Building Materials,* 221, 363-374.
82. Mehta, J. I. T. E. S. H., & Pitroda, J. K. (2016). Experimental investigation for the Kota stone powder as replacement of marble powder in marble brick. *Int J Curr Trends Eng Res (IJCTER),* 2(4), 105-111.