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An Experimental Investigation of Partial Replacement of sand by Marble Dust, Kota Stone Dust and Red Stone Dust

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ABSTRACT-Concrete is a very common building construction material. The aim of this experimental study to investigate the effect of various stone dusts like Marble dust, Kota stone dust, Red stone dust and they used as fine aggregate substitute. They have partial replaced 0%, 10%, 20%, 30% of the sand. The M30 grade of concrete grade is used. The slump test, Compressive strength test, Flexural strength test, Cylinder splitting tensile strength test are done. Marble has calcium compound and Redstone dust has silica content very much. Calcium compound and silica compound make C_2S and C_3S which increase the strength. So we have replaced the fine aggregates in two mixes- First mix with constant value of Marble dust (20% of sand) and Red stone dust as 0%, 20%, 40%, 60%, 80%. Second mix with constant value of Marble dust (20% of sand) and Kota stone dust as 0%, 20%, 40%, 60%, 80%. The slump test, Compressive strength test, Flexural strength test, Cylinder splitting tensile strength test are done.

Key Words- M- Marble Dust, K- Kota Stone Dust, R- Red Stone Dust, S- Sand

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I. INTRODUCTION

Concrete is a mixture of the cement, coarse aggregates, fine aggregates and water. For a concrete mixture river sand is generally used as the fine aggregates. In Rajasthan (India) the High court gave stay order of excavation of the river sand due to bad impact on environment of the river system and cause of river banks failure. On 10 May 2019 the Supreme Court also appreciate High Court decision on the hearing of review petition which is challenged to the High court order.

Now the stone dust is used for the replacement of sand. The marble, Kota stone, red stone etc. stones have waste dust when they are cut, polished in the industry. This dust is total waste, no further use is present.

A. **Properties of Marble**.

i. Physical properties of the marble-

- Colour – mostly use white marble now a day red marble, blue marble, pink marble, black marble
- Acid reaction- marble has calcium carbonate content which reacts with the various acids and does the neutralisation of the acid..

ii. Chemical composition of the marble-

$CaCO_3$	95-97%
SiO_2	2-3%
Fe_2O_3	0.5-1%%
Other	0.5-1%

Table-1 Chemical composition of Marble

B. Properties of Kota Stone

Kota stone is a famous fine grained limestone and known as building stone. Kota stone is known for flooring work. It is mainly found in Kota, Rajasthan, India.

i. Physical properties of the Kota stone-

- Colour – Earthy colour
- It is hard, tough and homogeneous compact stone. After polishing it shines

ii. Chemical composition of Kota stone

Lime (CaO)	38-46%
Silica	28-33%
Iron Ferrous oxide (Fe_2O_3)	13-17%
Alumina (Al_2O_3)	11-15%
Magnesia (MgO)	2-6%

Table-2 Chemical composition of Kota stone

C. Properties of Red Stone

Redstone is a type of sandstone which has red colour. Sandstone is the sedimentary rock. It is

generally used to make the door stone frames, sometimes for roofing and small construction work.

A. Physical properties of the Red stone-

- Colour – Red, Pink
- It is hard, tough and homogeneous compact stone
- It is a sand stone

B. Chemical composition of Red stone

Silica	38-46%
Iron Ferrous oxide (Fe_2O_3)	28-33%
Alumina (Al_2O_3)	13-17%
Lime (CaO)	11-15%
Magnesia (MgO)	2-6%

Table-3 Chemical composition of Red stone

Figure-1 Marble Stone, Kota Stone&Red Stone

II. GENERAL OUTLINE OF WORK

Material Used

In this experimental work various material are used. Following is the brief detail-

1. Cement (43 grade, JK cement)
2. Coarse aggregates (size of 20 mm, 10 mm)
3. Fine aggregates (Banas River Sand)
4. Marble Dust
5. Kota Stone Dust
6. Red Stone Dust
7. Admixture (K2 Super Plast)
8. Water

III. PREPARATION OF CONCRETE MIX

IV. RESULTS AND DISCUSSION

A. Compressive strength Test

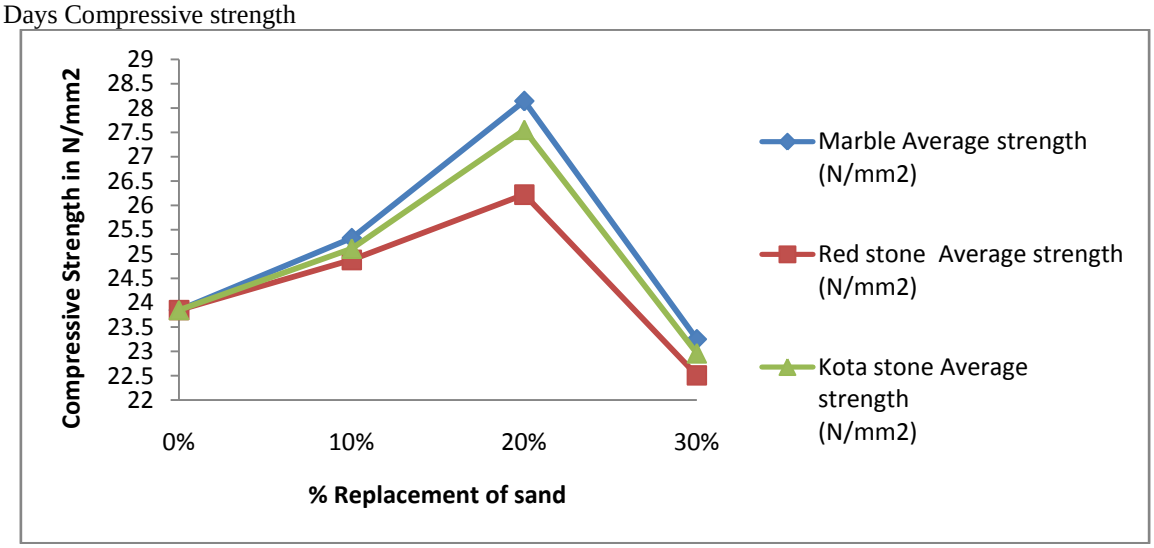
Compressive strength For Marble dust, Kota stone dust and Red stone dust as replacement of sand

a. 7 Days Compressive strength

7 Days Compressive strength

% Replacement Of Sand	Marble Average strength (N/mm^2)	Kota stone Average strength (N/mm^2)	Redstone Average strength (N/mm^2)
0%	23.85	23.85	23.85
10%	25.33	25.11	24.88
20%	28.14	27.55	26.22
30%	23.25	22.96	22.51

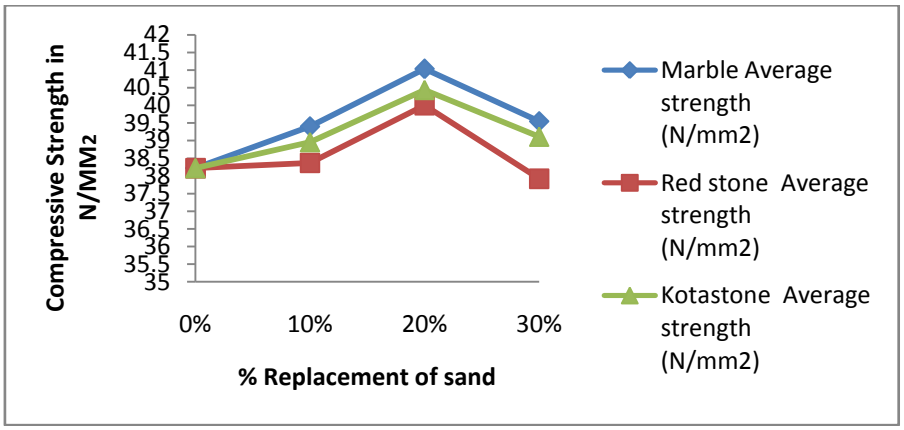
7 Days Compressive strength



b. 28 Days Compressive strength

28 Days Compressive strength

% Replacement Of Sand	**Marble Average strength (N/mm^2)**	**Kota stone Average strength (N/mm^2)**	**Redstone Average strength (N/mm^2)**
0%	38.22	38.22	38.22
10%	39.4	38.96	38.37
20%	41.03	40.44	40.00
30%	39.55	39.11	37.92



28 Days Compressive strength

- The above graphs shows that marble dust, kota stone dust, red stone dust till 20% replacement of sand gives the maximum compressive strength after that compressive strength decreases.
- Marble dust replacement till 20% replacement gives the highest values 28.14 N/mm^2 and 41.03 N/mm^2 in 7 days & 28 days compressive strength respectively.
- Kota stone dust replacement till 20% replacement gives the less values as compare to marble and gives more strength as compare to red stone dust which are 27.55 N/mm^2 and 40.44N/mm^2 in 7 days & 28 days respectively.
- Red stone dust replacement till 20% replacement gives the less values as compare to marble dust and Kota stone dust 26.22 N/mm^2 and 40 N/mm^2 in 7 days & 28 days compressive strength respectively.
- So for calcium compound and silica compound mixture as sand replacement we will take constant value of marble dust as 20% replacement of sand with marble dust because it gives maximum compressive strength.

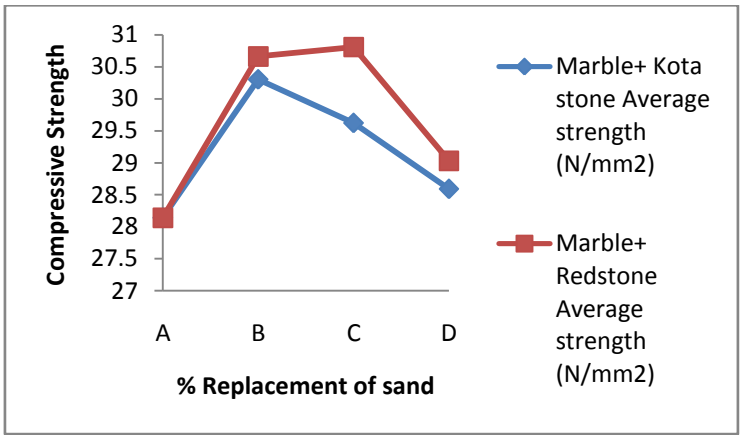
Compressive strength For Calcium Compound And Silica compound

a. Compressive Strength for 7 days

7 days Compressive Strength of mix of calcium compound and silica compound

	Mix Proportion	**Average Compressive Strength (N/mm^2)**		**Mix Proportion**	**Average Compressive Strength (N/mm^2)**
A	M 20% + K 0% + S 80%	28.14	A	M 20% + R 0% + S 80%	28.14
B	M 20% + K 20 % + S 60%	30.30	B	M 20% + R 20 % + S 60%	30.66
C	M 20% + K 40 % + S 40%	29.62	C	M 20% + R 40 % + S 40%	30.81
D	M 20% + K 60 % + S 20%	28.59	D	M 20% + R 60 % + S 20%	29.03

Where, M = Marble dust, K = Kota stone Dust, R = Red stone Dust and S = Sand

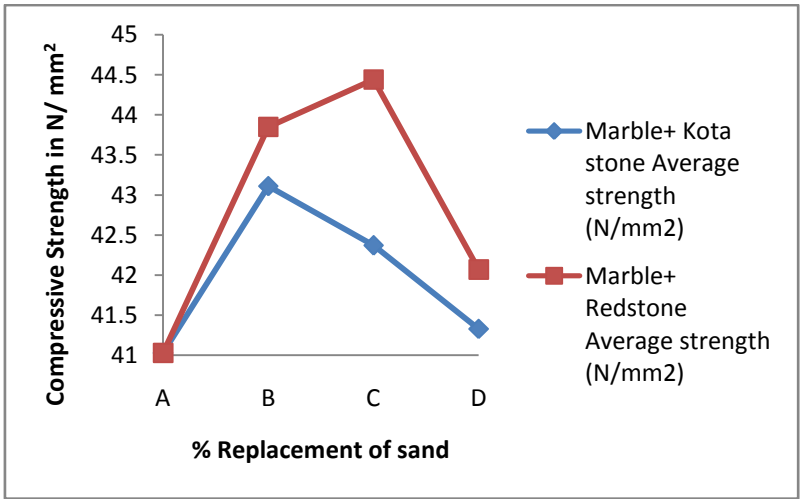


7 days Compressive Strength of mix of calcium compound and silica compound

b. Compressive Strength for 28 days

28days Compressive Strength of mix of calcium compound and silica compound

	Mix Proportion	**Average Compressive Strength (N/mm^2)**		**Mix Proportion**	**Average Compressive Strength (N/mm^2)**
A	M 20% + K 0% + S 80%	41.03	A	M 20% + R 0% + S 80%	41.03
B	M 20% + K 20 % + S 60%	43.11	B	M 20% + R 20 % + S 60%	43.85
C	M 20% + K 40 % + S 40%	42.37	C	M 20% + R 40 % + S 40%	44.44
D	M 20% + K 60 % + S 20%	41.33	D	M 20% + R 60 % + S 20%	42.07



Graph 4.4: 28 days Compressive Strength of mix of calcium compound and silica compound

There are two mixes. Marble has constant value 20% of replacement of sand. Further we used 0%, 20%, 40%, 60% kota stone and red stone dust as replacement of sand.

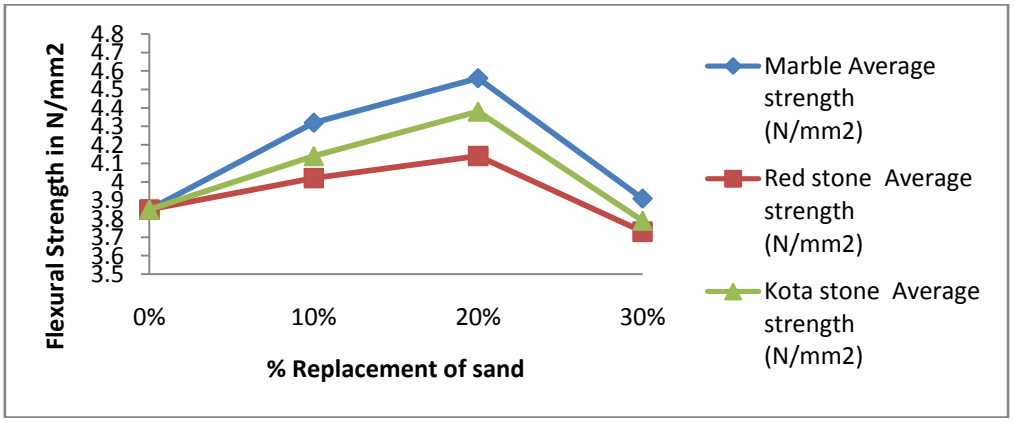
- The maximum value of compressive strength for marble dust and Kota stone dust mixture is at 20%-20% replacement of sand respectively.
- But the maximum value of compressive strength for marble dust and red stone dust mixture is at 20%-40% replacement of sand respectively.

Flexural strength Test

Flexural strength For Marble dust, Kota stone dust and Red stone dust as replacement of sand

28days flexural Strength

% replacement	Marble replacement Flexural Strength in N/mm^2	Kota stone replacement Flexural Strength in N/mm^2	Red stone replacement Flexural Strength in N/mm^2
0%	3.85	3.85	3.85
10%	4.32	4.14	4.02
20%	4.56	4.38	4.14
30%	3.91	3.79	3.73



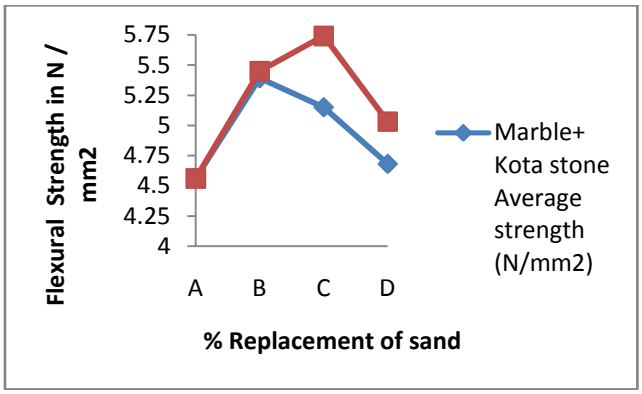
Graph 4.5: 28 days Flexural Strength

- The above graphs shows that marble dust, kota stone dust, red stone dust till 20% replacement of sand gives the maximum flexural strength after that flexural strength decreases.
- Marble dust replacement till 20% replacement of sand gives the highest values 4.56 N/mm^2 28 days flexural strength.
- Kota stone dust till 20% replacement of sand gives the less values as compare to marble dust at 20% replacement of sand and gives more strength as compare to red stone dust at 20% replacement of sand which is 4.38N/mm ^{2}
- Red stone dust t till 20% replacement gives the less values as compare to marble dust and kota stone dust 4.14 N/mm^2

Flexural strength For Calcium Compound And Silica compound

28days Flexural Strength of mix of calcium compound and silica compound

	Mix Proportion	**Flexural Strength in N/mm^2**		**Mix Proportion**	**Flexural Strength in N/mm^2**
A	M 20% + K 0% + S 80%	4.56	A	M 20% + R 0% + S 80%	4.56
B	M 20% + K 20 % + S 60%	5.39	B	M 20% + R 20 % + S 60%	5.45
C	M 20% + K 40 % + S 40%	5.15	C	M 20% + R 40 % + S 40%	5.74
D	M 20% + K 60 % + S 20%	4.68	D	M 20% + R 60 % + S 20%	5.03



Graph 4.6: 28 days Flexural Strength of mix of calcium compound and silica compound

There are two mixes. Marble has constant value 20% of replacement of sand. Further we used 0%, 20%, 40%, 60% kota stone and red stone dust as replacement of sand.

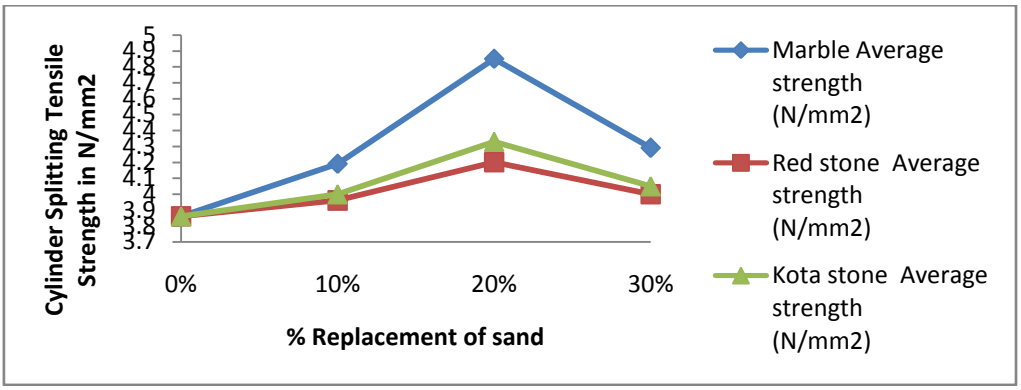
- The maximum value of flexural strength for marble dust and Kota stone dust mixture is at 20%-20% replacement of sand respectively.
- But the maximum value of flexural strength for marble dust and red stone dust mixture is at 20%-40% replacement of sand respectively.

Splitting Tensile Strength Test

Splitting Tensile strength For Marble dust, Kota stone dust and Red stone dust as replacement of sand

28days Cylinder splitting Tensile Strength

% replacement	**Marble replacement Cylinder Splitting Tensile Strength in N/mm^2**	**Kota stone replacement Cylinder Splitting Tensile strength in N/mm^2**	**Red stone replacement Cylinder Splitting Tensile Strength in N/mm^2**
0%	3.86	3.86	3.86
10%	4.19	4.00	3.96
20%	4.85	4.33	4.20
30%	4.29	4.05	4.00



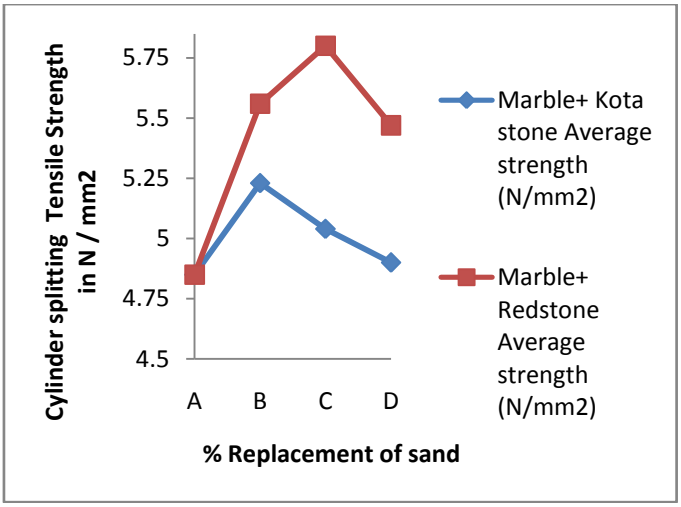
28 days Splitting Tensile Strength

- The above graphs shows that marble dust, kota stone dust, red stone dust till 20% replacement of sand gives the maximum split tensile strength after that split tensile strength decreases.
- Marble dust replacement till 20% replacement of sand gives the highest values 4.85 N/mm^2 28 days split tensile strength.
- Kota stone dust till 20% replacement of sand gives the less values as compare to marble dust at 20% replacement of sand and gives more strength as compare to red stone dust at 20% replacement of sand which is 4.33N/mm ^{2}.
- Red stone dust t till 20% replacement gives the less values as compare to marble dust and kota stone dust 4.20 N/mm^2 .

Splitting Tensile Strength For Calcium Compound And Silica compound

28 days Splitting Tensile Strength of mix of calcium compound and silica compound

	Mix Proportion	**Flexural Strength in N/mm^2**		**Mix Proportion**	**Flexural Strength in N/mm^2**
A	M 20% + K 0% + S 80%	4.85	A	M 20% + R 0% + S 80%	4.85
B	M 20% + K 20 % + S 60%	5.23	B	M 20% + R 20 % + S 60%	5.56
C	M 20% + K 40 % + S 40%	5.04	C	M 20% + R 40 % + S 40%	5.80
D	M 20% + K 60 % + S 20%	4.90	D	M 20% + R 60 % + S 20%	5.47



28 days Splitting Tensile Strength of mix of calcium compound and silica compound

There are two mixes. Marble has constant value 20% of replacement of sand. Further we used 0%, 20%, 40%, 60% kota stone and red stone dust as replacement of sand.

- The maximum value of split tensile strength for marble dust and Kota stone dust mixture is at 20%-20% replacement of sand respectively.
- But the maximum value of split tensile strength for marble dust and red stone dust mixture is at 20%-40% replacement of sand respectively.

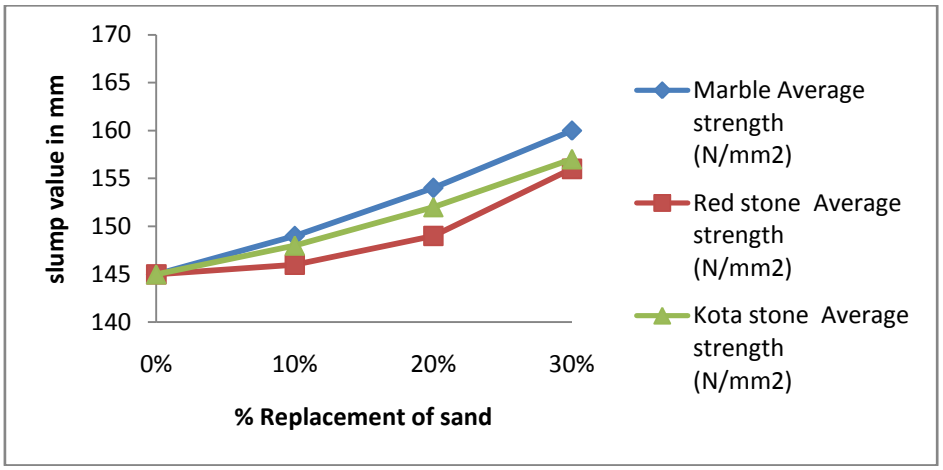
Workability Test

Slump test

When we mix the various dust as above described manner then workability of concrete increases.

Slump Test For Marble Dust, Kota stone Dust, Redstone Dust

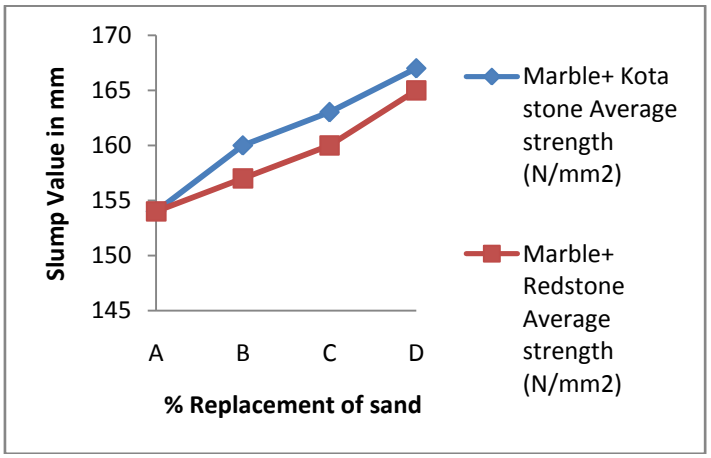
Replacement	Marble Dust	Kota stone Dust	Red stone Dust
0% Replacement	145	145	145
10% Replacement	149	148	146
20% Replacement	154	152	149
30% Replacement	160	157	156



Slump Test For Marble Dust, Kota stone Dust, Redstone Dust

Slump Test For Calcium Compound And Silica Compound

Mix Proportion	Slump		Mix Proportion	Slump
M 20% + K 0% + S 80%	154	A	M 20% + R 0% + S 80%	154
M 20% + K 20 % + S 60%	160	B	M 20% + R 20 % + S 60%	157
M 20% + K 40 % + S 40%	163	C	M 20% + R 40 % + S 40%	160
M 20% + K 60 % + S 20%	167	D	M 20% + R 60 % + S 20%	165



Slump Test For Calcium Compound And Silica Compound

V. CONCLUSIONS

For Marble Dust

Marble dust for replacement of sand till 20% gives the highest values of compressive strength, flexure, split tensile strength. The reason is that marble has very much lime CaO content as compare to Kota stone and red stone. The lime content has the properties to increase the compressive strength.After 20% replacement the compressive strength decreases. The excessive amount of CaO in the further replacement do not increase the compressive strength because silica content becomes less to make the calcium silicates.

For Kota Stone Dust

Kota stone dust for replacement of sand till 20% gives the higher value of compressive strength, flexure, split tensile strength from red stone dust. The reason is that Kota stone dust has lime CaO content. The lime content has the properties to increase the compressive strength.

After 20% replacement the compressive strength decreases. The excessive amount of CaO in the further replacement do not increase the compressive strength because silica content becomes less to make the calcium silicates.

For Red Stone Dust

Red stone dust for replacement of sand till 20% gives the lowest values of compressive strength, flexure, split tensile strength as compare to the marble dust and Kota stone dust. The reason

is that red stone has very less lime CaOcontent and more silica content as compare to Kota stone and marble. There is no role of only silica content to increase the compressive strength.

For Marble Dust And Red Stone Dust Mixture

The marble has more lime content and red stone has more silica content. When they replaced for sand then the CaO and SiO2 make the calcium silicates which increase the strength of the concrete.

For Marble Dust And Kota Stone Dust Mixture

The marble has more lime content and kota stone has efficient silica content. When they replaced for sand then the CaO and SiO2 make the calcium silicates which increase the strength of the concrete. But kota stone has less amount of SiO2 as compare to the red stone so the value of compressive strength is less.

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