Experimental study of concrete prepared by kota stone dust, bagasse ash, and recycled concrete

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Abstract: This paper mainly deals with the cost analysis of the concrete which is prepared using environmental waste which forms pollution and having its disposable issue also. This concrete may be termed as green concrete because the use of these materials decreases the harmful gas formation of the concrete. This paper deals with Kota Stone Dust, Bagasse Ash, and Recycled coarse aggregates. The concrete is prepared by the various ratios of Kota Stone in order of 5\%, 10\%, 15\%, 20\%, 25\% and 30\%. The use of bagasse ash was done in ratio 10\%, 20\%, 30\%, 40\% and use of Recycled Aggregate was done in ratio of 10\%, 20\%, 30\% and 40\%. After the successful experimental study of concrete using this material the cost reduction for M25 grade of concrete was found to be 645 INR.

Keywords: Cost analysis, Kota Stone, Bagasse Ash, Recycled Coarse Aggregate,

1. Introduction

Researchers around the world are practicing on concrete and its composition to get more from it. in this race many have succeeded with alternate materials like silica fume, fly ash, waste foundry sand, etc which are the perfect replacement of the cement, fine aggregate, and coarse aggregate. but this material may increase the cost of concrete. The studies also show us that many environmental wastes that pollute the land and having their disposable problem as well, can be reutilized in the concrete. This waste has pozzolanic action in them which allows them to create a bond with concrete and make a suitable environment. Concrete prepared by this waster can also be known as green concrete because there is a reduction of gas production from the concrete. After all, this waste doesn’t appreciate the gas formation.
Kota Stone Dust: - Kota stone is known to be the most used tiling material in the 20th century. When these tiles were cut into various handling pieces the dust was formed this dust can easily be used in the concrete. In other words, the Kota stone dust is a waste of the mining industry. In production India has its largest mining and production area in Rajasthan. [1] studies the effect of Kota stone slurry and rice husk ash in the concrete and stated that the use of these products can make concrete good against abrasion [2–4], but it can also decrease the durability of concrete. They also stated that the use of this material can decrease the price of the concrete. [5] stated that Kota stone slurry can also be used as the partial replacement of the cement which may affect the shrinkage and water absorption in the concrete. They also stated that Kota stone slurry can easily be used in mortar. Not only the Kota stone powder many other tone powder gives impressive results on the various mechanical properties of concrete. [6] studies the effect of marble powder on the concrete which makes a good increment in the mechanical properties of concrete.

Bagasse ash: - the most and widely consumed material is sugar. In 2019 it is reported that more than 300 million metric tonnes of sugar are being produced which leaves around 10 million metric tons of bagasse ash. [7] states that The density of this bagasse ash is too low that the only way to discard it is to dispose of it in the landfill which creates the land pollution problem. we can easily utilize this ash in concrete because it has pozzolanic action. [8] studies about sugarcane bagasse ash and stated that due to the pozzolanic action of SCBA [9,10], the rate of gain of strength is higher in the period of 28 days when compared to the 7-day rate. The purest form of bagasse ash can replace the fine aggregate.
by up to 30%. [11] studies about the behaviour of bagasse ash and steel fibers in reinforced cement concrete.

The bagasse ash can be utilized in two ways (1) in the wet state and (2) in wet state. If we use dry bagasse ash then the workability decreases when the percentage of replacement increases but when we use wet Bagasse ash than the workability increases because of the water content of the ash, see figure 1, 2 and 3.

Recycled Aggregate: the demand for industrialization also makes an increment in the demand of fine aggregate and coarse aggregate. [12] studies the effect of replacement of coarse aggregate by recycled coarse aggregate. The reduction of cost is RS130 but there is a decrease in the flexural strength of the specimen. [13] states that the full replacement of coarse aggregate is possible in certain conditions of admixtures and water content.

2. Experimentation Process
This experimental process is done with full care of materials and following Indian standards [14–21]. The room temperature was 25°C.

The physical properties of the material are taken as, see table 1.

| Specific gravity | Cement | 3.15 |
|------------------|--------|------|
|                  | Fine Aggregate | 2.6 |
|                  | Coarse Aggregate | 2.67 |
|                  | Bagasse Ash | 2.15 |
|                  | Kota Stone Dust | 2.8 |
|                  | Recycled Aggregates | 3.2 |

| Fineness | Cement | 97% |
|----------|--------|-----|
|          | Fine Aggregate | 3.2 |
|          | Coarse Aggregate | 7.8 |

The bagasse ash was taken from Morinda Sugar Factory Morinda, the taken sample was sieved and only the particles passed from 4.5-micron sieve are taken. Recycled aggregates were taken from the
Demolishing site of Chandigarh University Gharuan Punjab. The grading was done as same as done with coarse aggregate. The Kota stone dust was taken from the local stone supplier Morinda, Punjab. The process is conducted in three parts:
1. Replacement of Coarse aggregate
2. Replacement of fine aggregate
3. Replacement of Cement
First, the replacement of coarse aggregate was done with recycled coarse aggregate then the optimum value was found then at that percentage the various proportion of fine aggregate was replaced. Finally, at an optimum ratio of fine aggregate the replacement of cement was done which was found to be at maximum strength.

![Figure 4 Process of Experimentation](image)

The concrete grade is taken as M25 because this grade is widely used in the construction industry for residential and small commercial projects, see Figure - 4

### Results and Discussion

#### Table 2 Results for Experimentation Process

| Slump | Compressive | Flexure Strength | Split Tensile Strength |
|-------|-------------|------------------|------------------------|
|       | 7th Day     | 28th Day         | 7th Day                | 28 Day                | 7th Day | 28 Day |
| Nominal | 110 | 16.4 | 25.69 | 2.40 | 4.02 | 2.84 | 3.55 |
| RCA 10 | 108 | 16.7 | 26.1 | 2.42 | 4.05 | 2.86 | 3.58 |
| RCA 20 | 105 | 17.3 | 27.03 | 2.46 | 4.13 | 2.91 | 3.64 |
| RCA 30 | 100 | 17.0 | 26.5 | 2.43 | 4.09 | 2.88 | 3.60 |
| RCA 40 | 98  | 15.9 | 24.9 | 2.36 | 3.96 | 2.79 | 3.49 |
| RCA 50 | 88  | 15.0 | 23.5 | 2.29 | 3.85 | 2.71 | 3.39 |
| BA 10  | 102 | 17.7 | 27.6 | 2.48 | 4.27 | 2.94 | 3.68 |
| BA 20  | 94  | 18.0 | 28.2 | 2.51 | 4.41 | 2.97 | 3.72 |
| BA 30  | 90  | 17.9 | 27.9 | 2.50 | 4.19 | 2.96 | 3.70 |
| BA 40  | 80  | 17.1 | 26.65 | 2.44 | 4.10 | 2.89 | 3.61 |
Slump: - The replacement of coarse aggregate gives a reduction in the slump of the concrete because the RCA consumes more water than normal aggregates their water-absorbing capacity is higher than the normal aggregates. this value of slump also decreases when the fine aggregate percentage is increased because bagasse ash also absorbs the water. the slump value doesn’t change on the introduction of Kota stone powder because Kota stone powder does not absorb water and does no effect on the value of slump, see table 2 and figure 5, 6 and 7.
3.2. Compression strength: - When Recycled aggregates are introduced in the concrete they absorb some amount of water this aggregate makes an impressive increment in the compressive strength of concrete till 20% replacement of coarse aggregate but after that replacement due to extra and surface area of recycled aggregate it gives a negative impact but though 40% replacement is possible for the coarse aggregate. Use of recycled aggregate increase strength up to 5%.

An increase in strength was also seen at the addition of Bagasse ash due to its pozzolanic action the strength of concrete increases with an increase in replacement percentage but it also absorbs water because it is the ash of bagasse which has 50% water in it. Using this bagasse ash increases the compressive strength 4%.

The use of Kota stone dust in cement can increase the strength of concrete because it is likely to be finer than cement it fills the voids and increases the strength of concrete. The use of Kota stone makes an increment of 16% in the compressive strength, see figure 8 to 13.
3.3. Flexure strength replacing the coarse aggregate with recycled coarse aggregate doesn’t make enough increment in the strength of the concrete. It is maybe because aggregate does not contribute to the flexural strength of the concrete.

On the other hand, sugarcane bagasse ash makes a slight increment due to its pozzolanic properties of concrete.

Kota stone powder makes an increment in flexural strength at 15% it may due to its fineness like the cement.
3.4. **Split tensile strength** use of recycled coarse aggregate in concrete makes a very slight increase in the spilled tensile strength at 20% replacement of the concrete. Bagasse due to pozzolanic action makes a sufficient increment at 20% and Kota stone powder when replaced with cement makes increment at 15% of the concrete, see figure 14 and 15.

3.5. **Cost analysis** the cost analysis of the full experimental process was done in the references of Punjab Government, Public Works Department “Schedule of Rates”. All the rates were taken as the average of the “Schedule of Rates” and current market rates of the Mohali region. According to Mohali rates of concrete constituent particles, the rate of M25 is given in the table -3. the price of material and transportation the following rates are derived by taking Chandigarh university as a centre point. The rates of supplementary materials were taking in accordance with Punjab government PWD SOR rates, see Figure - 16.
Table 3 Cost Analysis for new composite concrete

| Material | Quantity for normal concrete M25 strength | Quantity for optimum strength | Rate | Total Rate (Rs) | Ratio | Quantity | Rate |
|----------|------------------------------------------|-------------------------------|------|-----------------|-------|-----------|------|
| Cement   | 7.65 bags                                 |                               | 320  | 3213            |       |           |      |
| Fine     | 0.64 cum                                  |                               | 1514 | 968.96          | 0.51  | 0.51 cum  | 772.14 |
| Coarse   | 0.87 cum                                  |                               | 787  | 684.69          | 0.70  | 0.70 cum  | 550.9 |
| Water    | 0.19 cum                                  |                               | 50   | 9.5             | 0.19  | 0.19 cum  | 9.5 |
| Kss      | 0.00 kg                                   |                               | 206 per 50 kg | 0 | 15 | 57.3 kg | 236 |
| Ba       | 0.00 cum                                  |                               | 1000 per cum | 0 | 20 | 0.12 cum | 128 |
| Rca      | 0.00 cum                                  |                               | 206 per cum | 0 | 20 | 0.17 cum | 35.02 |
| Total    |                                          |                               | 4876.15 |                  |       |           | 4230.56 |

4. Conclusion

1. Replacement of coarse aggregate with recycled coarse aggregate can be optimum replaced up to 20% by gaining the increment of 5% in compression, 2% in flexure, and 2% in split tensile strength. The recycled coarse aggregate can replace up to 40% in the M25 mix.
2. Due to the pozzolanic action of sugarcane bagasse ash it can be replaced up to 30% of fine aggregate but the optimum replacement can be achieved at 20percentage replacement which gives a 4% increase in compression 2% increase in flexure and 2% increase in split tensile strength of concrete.
3. Kota stone powder is likely to be finer as cement which increases the compression 15%,
flexure 3%, and split tensile strength 7% when replaced 15% by the weight of cement.

4. In a combination of 20% recycled coarse aggregate, 20% bagasse ash, and 15% Kota stone powder the increase in compressive strength is 26%, increase in flexure and split tensile strength is 12%.

5. At the ratio of replacement of 20:20:15 of Recycled coarse aggregate, sugarcane bagasse ash, and Kota stone powder the reduction in the cost of concrete is 645INR

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