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# Experimental analysis of Ceramic waste in partial replacement of fine aggregate in paver block

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**1. Abstract**

Waste management is becoming major problem for developing countries nowadays. In order to reduce the solid waste, we have planned to take one waste to use in manufacturing of concrete. Broken ceramic pieces is made as powder and used as a partial replacement for fine aggregate i.e.10%, 20%, and 30% for natural sand in paver block. Admixtures are used to reduce the water cement ratio in order to gain more strength in the high performance concrete. The water absorption properties of ceramic dust are very less compared to that of natural sand. Since the solid waste (ceramic dust) is used in the manufacturing paver block the cost is required only for crushing the waste glass therefore the overall cost can also be reduced. Compressive strength of cube at 7, 14, 28 days of duration and flexural strength at 28days were studied and compared with conventional concrete paver block. Physical properties like fineness modulus, specific gravity, moisture, water absorption were studied and compared with conventional concrete mix. Based on the test results, the 20% replacement shows better results compared to conventional concrete paver block.



**2. Introduction**

Paver block is an artificial material obtained by cementing together fine and coarse aggregates chips(sand and broken stone of size 10mm) using a binding material. The strength of concrete paver block depends on many factors like proportion of the component materials, amount of water used during mixing, size and grading of aggregates, method mixing/compaction temperature and humidity at the time of mixing, molding and curing etc.,

Ceramic dust is one of the man-made materials. Large amount of ceramic wastes is produced and disposed to landfill site day by day where ceramic cannot be decomposed because it is non-biodegradable waste. It could be recycled indefinitely and used many times.

The most widely used fine aggregate in concrete is river sand and M-sand. Because of its increased cost and scarcity, it will make the way for usage of substituent materials. Increase of usage of crushed waste ceramic content in concrete will decrease the density so that the self-weight of the concrete is reduced.

Conplast SP430 is used as admixture for increasing the strength concrete; admixtures are added to reduce the water content in concrete without reducing its workability. Produces dense concrete with improved workability.

**Fig 1.Waste ceramic powder**

**3.Literature review**

**Hitesh kumarMandavi, VikasSraivastava, V.C.Agarwal**concluded that high compressive strength can be achieved due to dense packing of voids by Ceramic powder of size (2.36mm) is used.

**BhimajiDashrathKanawade, SonaliRatnakarNawale** Studied about different testing methods like Compressive Strength, Split tensile strength, Abrasion test, Flexure, Breaking load of paver block.

**A.R.Pradeep, M.I.Basavalingagowda** Due to scarcity of natural resources like sand partial replacement of aggregate using ceramic fine aggregate for sand is used.

**Amitkumard.Raval, DR.IndrajitN.Patel, Prof.JayeshkumarPitroda** On disposing ceramic waste powder in land causes environmental pollution threatening agriculture and public health so on replacing it in concrete is aecofriendly concrete from ceramic waste.

**G.Sivaprakash, V.Saravanakumar and Lakijotisaikia**the effect of waste product like ceramic waste in the strength properties with partial replacement for sand with 10%,20%,30%,40%,50% is tested.

**Samreen Taj, Syed Ruman Pasha** reuse of ceramic waste for coarse aggregate in concrete has been investigated for proportions 0%,10%,20%,30% in M20 grade concrete is made and compressive strength and split tensile strength is done.

**E.E.Ikponmwosa and S.O.Ehikhuenmen**the decrease in density and strength of concrete due to replacement of ceramic waste being lighter and more porous than normal coarse aggregate the strength parameters declination is analysed

## 4. Material Properties

### a) Ceramic Powder

Waste ceramic is crushed into fine powder (less than 4.75mm) is used in concrete mix. Generally, million tons of wastes are produced. In order to overcome the problem waste ceramic is used as partial replacement of fine aggregate in concrete paver block.

**Table 1.Physical properties of sheet glass powder**

| Property | Value |
|---|---|
| Specific Gravity | 1.98 |
| Water Absorption | 6.42% |
| Bulk Density(g/cm^3) | 1.29 |
| Impact Test | 22.45% |

### b) Cement

Cement is one of the mainly used binding materials in construction field.It is very fine powder which is made from lime stone,clay, bauxite,iron ore etc.It is mixed with sand to form mortar and used for brick masonry.

**Table 2. Properties of cement**

| Property of Cement | Values |
|---|---|
| Fineness Of Cement | 2.41% |
| Grade Of Cement | 53 |
| Specific Gravity | 3.15 |
| Initial Setting time | 32 minutes |
| Final Setting Time | 600 Minutes |

### c) Fine Aggregate

Sand is naturally occurring material from rocks in the river banks. Different types of sand are used in construction but nothing can replace the properties of river sand. Sand passing through 2.36mm sieve size is used for casting the specimens.

**Table 3. Properties of Fine Aggregate**

| Properties | Values |
|---|---|
| Specific Gravity | 2.467 |
| Fineness Modulus | 2.22 |

### d) Coarse aggregate

Aggregate passing 20mm sieve and retained in 12.5mm is considered as coarse aggregate which is mixed up with cement and sand and used in concrete.

**Table 4. Properties of Coarse Aggregate**

| Properties | Values |
|---|---|
| Specific Gravity | 2.792 |
| Size Of Aggregates | 10 mm |
| Fineness Modulus | 2.63 |

### e) Water

Casting and curing of specimens were done with the potable water as per IS 456:2000.

**Table 5.pH Value Test**

| WATER | pH VALUE |
|---|---|
| Sample 1 | 7 |
| Sample 2 | 7 |
| Sample 3 | 7 |

## 5. Mixture Preparation for Cube Casting

**Table 6. Mix Proportion ($M_{25}$)**

**Table 7. Mix Proportions of Concrete**

| Ceramic Powder (%) | 0 | 10 | 20 | 30 |
|---|---|---|---|---|
| Cement (kg/m3) | 370 | 370 | 370 | 370 |
| FA (kg/m3) | 964.72 | 868.32 | 771.85 | 675.31 |
| CA (kg/m3) | 893.30 | 893.3 | 893.3 | 893.3 |
| Water (kg/m3) | 166.4 | 166.4 | 166.4 | 166.4 |
| Ceramic Powder(kg/m3) | 0 | 96.47 | 193.48 | 289.41 |

| Concrete mix | Water | Cement | FA | CA | Admixture |
|---|---|---|---|---|---|
| M 25 | 166.4lit | 370 kg/m³ | 964.72 kg/m³ | 893.3kg /m³ | 7.4 lit |

| Concrete Mix | Partially compacted concrete (kg) | Fully compacted concrete (kg) | Compaction factor |
|---|---|---|---|
| M25 | 11.50 | 13.80 | 0.834 |
| 10% CW | 12.82 | 15.16 | 0.845 |
| 20 % CW | 12.87 | 15.93 | 0.807 |
| 30% CW | 12.31 | 15.261 | 0.806 |

## 6. Experimental methodology

### i) Casting of Cubes

Cubes were made (Fig. 3.9.2) using concrete mixture without CD and concrete mixture Containing CDas partial replacement of fine aggregate with various percentages ( 10%, 20% and 30%).

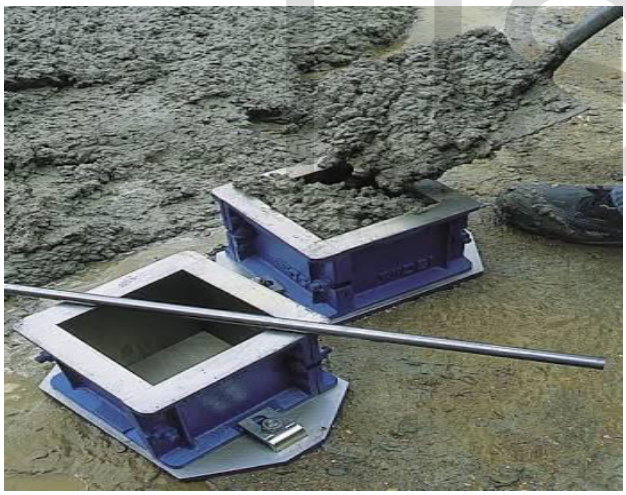


**Fig. 2. Casting of Concrete Cubes (M50)**

### ii) Curing of Concrete Cubes and Beams

After casting, all the test specimens were stored at room temperature in the casting room. They were de-moulded after 24 hours, and were put into a water-curing tank for 28 days at room temperature.

## 7. Test on fresh concrete

**Table 9. Compaction Factor Test (GP)**

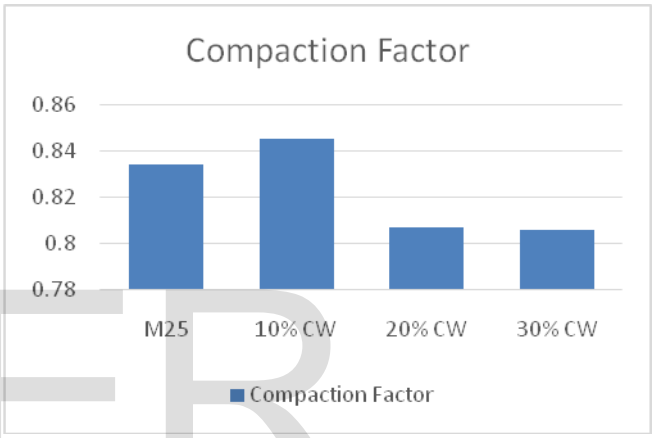
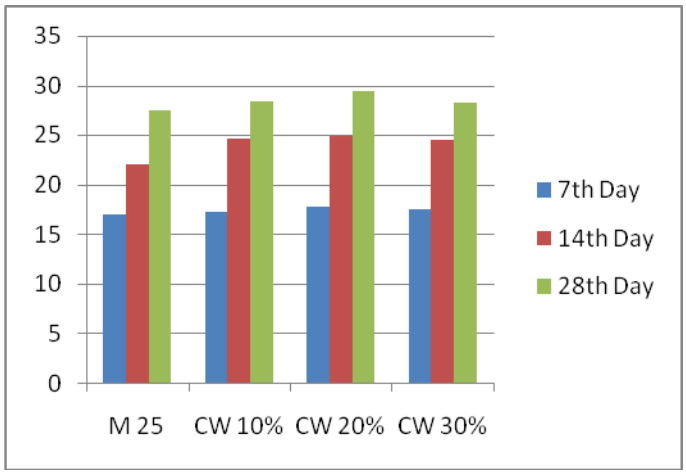



**Table 10. Compressive strength test (N/mm2)**

| Concrete Mix | 7th Day | 14th Day | 28th Day |
|---|---|---|---|
| M25 | 17 | 22 | 27.5 |
| CW 10% | 17.25 | 24.66 | 28.35 |
| CW 20% | 17.8 | 24.85 | 29.49 |
| CW 30% | 17.52 | 24.53 | 28.20 |




## 8. CONCLUSIONS

From the results of this investigation, the following conclusions are made:

- The use of ceramic waste in concrete paver block is an effective way of disposal.
- The compressive strength of paver block is maximum at 20% of replacement with fine aggregate.
- The test result shows clearly thet the ceramic waste can be used as a replacement material of river sand and M sand in concrete.
- The tensile strength of 10%, 20%, 30% replacement shows the consistency in attaining the required range.
- The use of ceramic waste is an effective way for reducing the cost of paver block.

## 9.REFERENCES

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