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# Effect of Compressive Strength of Concrete with Partial Replacement of Cement by Ceramic Waste

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**Abstract—***With the increasing population and a huge demand of civil engineering structures, use of concrete for constructing such structures has increased tremendously. In order to make these concrete structures economical and eco-friendly, many civil engineers have found out many ingredients which may be a day to day waste yet it can be very useful for these concrete structures to make them safer. Thus, some of the waste such as silica fume, blast furnace slag, rice husk, etc. is commonly used as a replacement of cement. Now-a-days along with safety, people also go for aesthetic views of the structures and ceramic products are largely in use in civil engineering fields. This study includes a different type of waste i.e. ceramic powder waste in constructing the structures of Assam, considering the reviews of various research papers of authors of known journals. Ceramic material is hard and rigid and it is estimated that of the total raw materials used 15%-30% are waste material. Partial replacement of cement by ceramic powder waste up to 30% will help increasing the compressive strength of cubes in 7 days and 28 days.*

**Keywords***: ceramic powder waste, compressive strength, economical, eco-friendly*

## 1. INTRODUCTION.

As time passes, day by day population increases and hence demand for new civil engineering structures are increasing. Concrete is one of the most important elements of any such structures. Concrete is a composite man-made material and it is composed by mixing mainly cement, fine aggregates and coarse aggregates. Constituents of concrete i.e. fine aggregates and coarse aggregates are inert ingredients and cement and water are active ingredients and when water is mixed with cement it gives a chemical reaction which causes the cement to harden. This chemical reaction is called hydration. Again, concrete is strong in compression and weak in tension.

May it be a residential building, commercial building, educational building, etc. it is made up of concrete and because of its high demand in recent times many civil engineers has found out many alternatives for cement, fine aggregates and coarse aggregates. Engineers are concentrating in reusing of waste generated from various industries.

The most important element for concrete is the cement. Cement is the powder when mixed with water it hardens and forms the matrix of the concrete. Thus, cement can be replaced by various waste generated by industries which are dumped in open fields which leads to pollute the environment. Hence, reusing of such waste not only helps in reducing the pollution but also in developing structures which are economical and eco-friendly. Some of the commonly used waste is silica fume, blast-furnace slag, rice husks, etc. but there are also some other alternatives such as ceramic powder waste, waste glass powder etc. In this study, ceramic powder waste as the partial replacement of cement has been used. Today, people not only go for safety but also look for the aesthetic views of the structures. Ceramic products are the ones to give beauty to any of structures may it be big or small. Thus, ceramic products are greatly in use. With the use of such products there are also waste generated from those industries. These waste were dumped in open fields, but now civil engineers reuses these waste product in the form of fine powder and is used as the partial replacement of cement in concrete structures which make the structure eco-friendly and economical.

In India, ceramic production is about 100 million ton per year and among that 15%-30% of it is generated as solid waste in the form of powder. It is to be deposited safely in order to avoid serious environmental pollution. Hence, using ceramic waste in construction is a better solution for its disposal [1,2,3].

## 2. 2. CONCRETE.

Concrete is a composite material made by mixing cement, fine aggregates, coarse aggregates and water. It is a porous material i.e. it depends on the pore spaces and is strong in compression and weak in tension. To make the structure stronger in tension also, it is provided with reinforcing bars. Various chemical admixtures and plasticizers are also mixed with the concrete mixture to achieve varied properties. Concrete can be damaged by many processes such as freezing of trapped water. Concrete is widely used to make many structures such as dams, foundations, footing, panels, bridges, etc.

### 2.1. Characteristics of concrete:

- Concrete as a building material: Almost all civil engineering structures are made up of concrete. It may be cast in bricks, blocks and any other building material which is used for construction.
- Strength of concrete: Concrete is weak in tension and strong in compression. Thus, in order to resist the structure from twisting, bending and stretching, it must be reinforced with steel bars.
- Water-tightness: There must be enough water required for complete hydration of cement.
- Durability of concrete: concrete must be able to resist deteriotion caused by exposure to service condition.

## 3. EFFECT OF USING CERAMIC POWDER WASTE IN CONCRETE.

The characteristics of ceramic waste are that it is hard, durable, and highly resistant to biological, chemical and physical degradation of forces [2]. The properties of cement such as consistency, setting time, soundness, etc. remains acceptable in different standards when replaced up to 10% of the cement by ceramic waste powder [5]. The properties of cement such as consistency, setting time, soundness, etc. remains acceptable in different standards when replaced up to 10% of the cement by ceramic waste powder [5]

**Table 1.Chemical properties of ceramic waste:**

| MATERIALS | CERAMIC POWDER% |
|---|---|
| SiO2 | 63.29 |
| Al2O3 | 18.29 |
| Fe2O3 | 4.32 |
| CaO | 4.46 |
| MgO | 0.72 |
| P2O5 | 0.16 |
| K2O | 2.18 |
| Na2O | 0.75 |
| SO3 | 0.10 |
| CL- | 0.005 |
| TiO2 | 0.61 |
| SrO2 | 0.02 |
| MnO3 | 0.05 |
| L.O.I | 1.61 |

Source: GEO TEST HOUSE, Gujarat [1,2,3]

**Table 2: Comparative cost of cement and ceramic waste powder [2,3]:**

| MATERIALS | RATE (Rs/Kg) |
|---|---|
| CEMENT | 6.40 |
| CERAMIC WASTE POWDER | 0.20 |

### 3.1. Compressive Strength.

- Replacement of cement by its weight by ceramic waste powder i.e. 5% of waste marble powder and 15% of crushed tile aggregate will result in increase in compressive strength of the concrete cube. [5]
- Increase in compressive strength of 7 days and 28 days curing period shows that ceramic waste powder (waste marble powder) possess cementing properties. [5]

### 3.2. Durability and Strength.

- Ceramic powder waste i.e. roof tile powder concrete blocks shows higher insulating properties as compared to conventional concrete blocks. [4]
- It also shows a density reduction at the rate of 3% as compared to the conventional concrete blocks. [4]

### 3.3. Cost Reduction.

Ceramic waste powder is low cost than that of cement and hence there will be reduction in the overall cost of building a structure.

## 4. CONCLUSION

With the huge demand of civil engineering structures, engineers need to take care that the structure is safe, economical and environment friendly. In this study, it is found that there is about 100 million ton of ceramic waste per year and it is dumped in open spaces near the industry which pollutes the environment. Thus, the safe disposal of the ceramic waste is to use such waste in construction sites. Now-a-days, in Assam also people along with safety goes for aesthetic views and thus while using ceramic products for giving beauty to the structures, engineers can also use ceramic powder waste as a partial replacement of cement. From the reviews of various authors of known journals, it is found that when ceramic waste powder is used up to 30% replacement of cement by its weight, it results in increase in compressive strength. It is also found from the reviews of the authors that ceramic waste powder is much cheaper as compared to cement. Thus, the structures made using this waste will be economical.

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