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# Experimental Investigation on Concrete with Partial Replacement of Waste Glass as Coarse Aggregate

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**ABSTRACT:** This experimental study aimed to design a concrete mixture with recycled bottles as an alternative coarse aggregate for mass housing projects. That will help in contribute to the industry in saving the environment, to encourage the government to find solutions regarding the disposal to landfills of waste materials and provide new knowledge to the contractors and developers on how to improve the construction industry methods and services by using recycled bottles, and to sustain good product performance and meet recycling goals. A conventional concrete product was compared to concrete with recycled bottles of the same proportions. Observations from the tests performed were conducted in the laboratory where precise data were gathered and completely attained.

**KEYWORDS:** Recycled Aggregate, Glass fibre, Fly ash

## I. INTRODUCTION

As time goes by, human civilization is continuously becoming more industrialized. More factories are built, vehicles are continuously growing in number, and buildings were built all around. As a result of these, our natural environment was permanently changed from what it has been twenty years or more.

Over the last several decades, sociologists have investigated the public's increasing concern about the environment, but they have had little success explaining attitudes. Toward the environment or the adoption of pro- environment behaviors like recycling the researcher examine the role of social context in the link between individual attitudes about the environment and recycling behavior by comparing communities that vary in their access to recycling programs. Results show that people with access to a structured recycling program have much higher levels of recycling than do people lacking such access. Furthermore, individual attitudes toward the environment affect recycling behavior only in the community with easy access to a structured recycling program. Individual concern about the environment enhances the effect of the recycling program, but does not overcome the barriers presented by lack of access.

The human population is continuously growing in number, because of this; there is a great demand of constructing more structures to facilitate the needs of the community. Quarry operations become rampant to satisfy the need for gravel and sand for construction. As a consequence there are massive destruction of mountains which has been one of the major costs of landslides, and flash floods during earthquakes and typhoons resulting to loss of thousands or even millions of lives.

## II. LITERATURE STUDY

**1. Tomas U. Ganiron Jr** studied about the partial replacement of cement in concrete by use of waste materials like cement kiln dust (CKD), ceramic waste, palm oil fuel ash (POFA) and plastic. All of these materials are industrial waste materials and termed as hazardous waste to environment. They have found that the addition of up to 15% CKD as a cement replacement has a negligible effect on the strength of the block. Several concrete mixes possessing a target mean compressive strength of 30 MPa were prepared with 20% cement replacement by ceramic powder (W/B = 0.6).

**2. Turgut.P and Yahlizade.E.S** investigated the effect of strength of concrete with partial replacement of cement with quarry dust and Metakaolin. They have stated that concrete is a composite material made from cement,

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water, fine aggregate and coarse aggregate. But present researchers are in interest of finding new cement materials by waste materials or waste products produced from industries which are harmful to environment.

**3. Dr. Zubaidah Abdullateef.M.A.Al-BayatiTomas Ucol-Ganiron Jr** investigated about the partial replacement of cement in concrete by use of waste materials Steel Slag. Slag is a byproduct of metal smelting and hundreds of tons of it are produced every year all over the world in the process of refining metals and making alloys. Like other industrial by products, slag actually had many uses, and rarely goes to waste. It appears in concrete, aggregate road materials, as ballast, and is sometimes used as a component of phosphate fertilizer.

**4. Md. Safiuddin et al** investigated to use of poultry waste in concrete through the development of concrete incorporating eggshell powder (ESP). Different eggshell powder (ESP) concretes had developed by replacing 5-15% of ESP for cement. The results indicated that eggshell powder (ESP) can successfully be used as partial replacement of cement in concrete production. The data presented cover strength development and transport properties.

**5. R.Balamurugan and R.Karthikraja** studied about seek to greener environment since it seeks to develop recycle waste material for construction. The use of recycle aggregates and solid wastes from construction and demolition waste is showing a prospective application in construction and as alternative to primary and natural aggregate. It conserves natural resources and reduces the space required for land fill disposal.

### III. MATERIALS

Ordinary Portland cement of 53 grade with standard consistency of 30% and specific gravity of 3.15. Fly ash of class F with specific gravity of 2.31 will be used. Fine aggregate conforming to IS: 383-1970 with 2.42 specific gravity and 0.50% water absorption and specific gravity of 2.78 was used for preparation of concrete specimens.

#### Recycled Aggregate

Any construction activity requires several materials such as concrete, steel, brick, stone, glass, clay, mud, wood, and so on. However, the cement concrete remains the main construction material used in construction industries. For its suitability and adaptability with respect to the changing environment, the concrete must be such that it can conserve resources, protect the environment, economize and lead to proper utilization of energy. To achieve this, major emphasis must be laid on the use of wastes and by products in cement and concrete used for new constructions. The use of recycled aggregates from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates.

#### Glass fibre

Glass is an amorphous (non-crystalline) solid material. Glasses are typically brittle and optically transparent. The most familiar type of glass used in windows and drinking vessels is soda-lime glass, composed of about 75% silica (SiO<sub>2</sub>) plus Na<sub>2</sub>O, CaO, and several minor additives. Often, the term glass is used in a restricted sense to refer to this specific use.

**Table 1: Specific gravity of conventional coarse aggregate and glass coarse aggregates**

Material	Specific gravity
Conventional coarse aggregate	2.58
25:75 (Glass: Aggregate)	2.06
50:50 (Glass: Aggregate)	2.11
75:25 (Glass: Aggregate)	2.10

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## IV. EXPERIMENTAL INVESTIGATION

### Mixing

Ordinary OPC 43Grade, Fine aggregate, Glass coarse aggregate and water cement ratio are taken as per mix design and toughly mixed.

### Casting

The concrete cubes, cylinders and beams were cast in moulds in such a way as to produce full compaction of concrete with neither segregation nor excessive laitance. The concrete is filled into the mould in three layers approximately 5cm deep. Each layer was well compacted. After the compaction, the top surface is finished level with the top of the mould using a trowel. The standard tamping rod was used and the strokes of the rod were distributed in a uniform manner over entire mould. The number of stokers per layer required to produce the specified conditions, vary according to the type of concrete.



Figure 1: Casting of Specimens



Figure 2: Curing of Specimens

### Curing

The specimens were demoulded after 24 hours of casting. Necessary identification marks were made in the specimens and kept under water in a curing tank. The specimens were kept under water for 7 days, 14 days and 28 days. After curing, they were taken out from the curing tank and air dried before testing.

### Testing

#### 1. Compressive strength test

The compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test. The apparatus used for this experiment is the same as that used in a tensile test. However, rather than applying a uniaxial tensile load, a uniaxial compressive load is applied. The compression test is carried out on the 7, 14 and 28 days cured specimens. The size of cube specimen is 150mm x 150mm x 150mm. Totally 42 were caste and tested using the compression testing machine.

$$\text{Compressive strength} = \left[ \text{Failure load (N)} / \text{Sectional area (mm}^2\text{)} \right]$$

#### 2. Splitting Tensile Strength

Cylinder Splitting tension test or “Brazilian test” was first used at Brazil and Japan. The size of the cylinder specimen is 150mm (Dia) x 300mm (Length). Take the wet specimen from water after 7 days of curing. Wipe out water from the surface of specimen. Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place. Note the weight and dimension of the specimen. Set the compression testing machine for the required range. Keep are plywood strip on the lower plate and place the specimen. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate. Place the other plywood strip above the specimen. Note down

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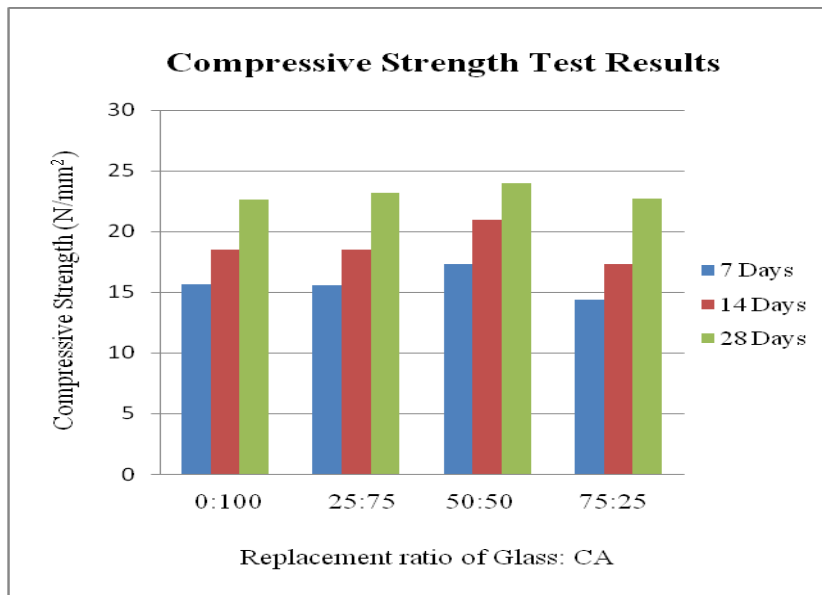
the breaking load (P).  
Splitting tensile strength =  $2P / \pi LD \text{ mm}^2$

### Test Results

The test result shows that the replacement of aggregate by glass has more compressive and tensile strength than conventional concrete. After the replacement of 50 % the strength will be reduced drastically. The tables and figures show the compressive strength and split tensile strength of the concrete.

**Table 2: Compressive Strength Test Results**

Curing period	Compressive Strength(N/mm <sup>2</sup> )			
	0:100 (Glass: C.A)	25:75 (Glass: C.A)	50:50 (Glass: C.A)	75:25 (Glass: C.A)
7 Days	15.64	15.53	17.32	14.36
14 Days	18.53	18.52	20.96	17.30
28 Days	22.58	23.20	23.96	22.68



**Figure 3: Compressive Strength Test Result Graph**

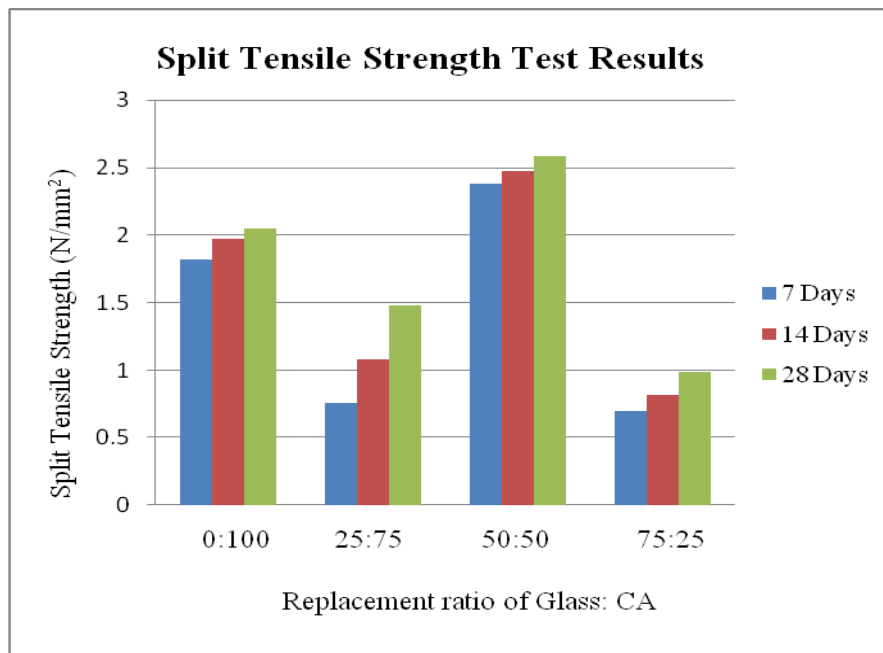
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**Table 3: Split Tensile Strength Test Results**

Curing period	Split Tensile Strength(N/mm <sup>2</sup> )			
	0:100 (Glass: C.A)	25:75 (Glass: C.A)	50:50 (Glass: C.A)	75:25 (Glass: C.A)
7 Days	1.82	0.76	2.38	0.7
14 Days	1.97	1.08	2.47	0.82
28 Days	2.05	1.48	2.58	0.99



**Figure 4: Split Tensile Strength Test Result Graph**

## V. RESULT AND DISSCUSSION

The test result shows that the partial replacement levels of glass as a aggregate replaced upto 50% shows better compressive strength than conventional concrete and more than 50% replacement levels. The split tensile strength of the glass coarse aggregate shows better result in 50% replacement level only.

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## VI. CONCLUSION

In this research the compressive strength and split tensile strength of the glass replaced aggregate concrete shows more strength than conventional concrete. It is an economical concrete in which the waste construction glass material is utilised for concrete work.

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