Use of Wheat Straw Ash as Cement Replacement Material in the Concrete

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Abstract: **Many researchers are conducting experimental studies that focus on finding the possibility for alternatives to be used as cement substituting materials that are eco-friendly, economical and effective. The alternatives include industrial and agricultural wastes, whose potential benefits can be appreciated through recycling, reutilizing and renewing processes. With utilization of these wastes as supplementary and replacement materials there is considerable energy conservation and reduction in the consumption of cement which aids in the reduction of release of carbon dioxide in the environment. In this research work, wheat straw ash an agricultural waste is used as cement replacement material. The cement replacement percentages are 0%, 5%, 10%, 15% and 20%. A total 45 cubical specimens were cast, cured and tested at the curing ages of 7, 28 and 90 days and compressive strength of concrete was determined. The results showed maximum compressive strength at 10% cement replacement and minimum strength at 20% cement replacement.**

***Keywords*: Agricultural Waste, Cement Replacement, Wheat Straw Ash**

I. INTRODUCTION

Concrete is an artificial material used extensively and globally for a long time. Concrete is a composite of fine and coarse aggregate combined with hydraulic paste of cement and water [1]. It is the indispensable building construction material, and also important in other projects of infrastructure around the globe. It is experienced as the second material far and wide used by mankind. In fact, the utilization of natural resources i.e. natural aggregates as coarse and fine, cement as binding material for the production of concrete has caused a lot of degradation in the natural resources [2]. From ecological point of view, creation of concrete is mostly responsible for the release of greenhouse gases. It is reported that yearly production of concrete is about 1.6 billion tons worldwide, which discharges 7% of the global carbon dioxide into the atmosphere [3]. Keeping in view these concerns of environment, cost of materials for construction, shortage of raw materials and higher demand of energy, practice of utilizing alternate solid waste material is becoming a common concern of the globe [4]. Many researchers have conducted experimental studies that focused on finding possibility for alternatives to be used as cement substituting materials, that are of less worth which include industrial and agricultural wastes, whose potential benefits can be appreciated through recycling, reutilizing and renewing processes. Hence, scholars have been exploring the effective and practical use of waste materials which are pozzolanic in nature as a cement substitute [5]. It is suggested by researchers that consumption of supplementary cementitious materials in concrete helps to reduce the adverse environmental effects related to the manufacturing process of cement or concrete [6]. With utilization of these wastes as supplementary and replacement materials there is considerable energy conservation and reduction in the consumption of cement which aids in the reduction of release of carbon dioxide in the environment [7]. Moreover, there could be considerable improvement in the strength and durability properties with use of supplementary cementing materials in concrete. Therefore, wide-range research has been carried out on number of supplementary materials, like rice husk ash, metakaolin ash, sewage sludge ash, palm shale oil, etc [8]. A major agricultural by-product obtained from cereal production is wheat straw waste, which encourages environmental pollution because the farmers burn it in open fields. However, when wheat straw waste is properly burnt under controlled situation results in a material that has cementing properties and that can be used in concrete as supplementary cementing material [9]. The resulting ash has higher percentage of silica present, also higher fineness compared to cement, therefore the wheat straw ash is considered as the possible source of supplementary cementing material [11]. The advantage of utilizing WSA in concrete as cementitious material in concrete was revealed when WSA increased compressive strength up to 25% of mortar at replacement level of 20% [12]. As durability is one of the important properties of concrete, therefore researchers are also investigating on the durability aspects of concrete while using WSA as replacement material. It was found that when cement was replaced by WSA, the resulting concrete performed better when exposed to sodium and magnesium sulphate solutions in terms of compressive strength as compared with conventional concrete [14].The improved durability is due to the pozzolanic and filler actions of WSA in concrete. The replacement of cement by WSA in concrete resulted in higher resistance to freeze-thaw and alkali-silica reaction was reported by Al-Akhras (2011). Additionally, Researchers utilized WSA as filler material in concrete due to the fineness of particles. The fine aggregates replacement by WSA in concrete enhanced compressive strength, improved resistance to sulphate, thermal cycling, abrasion and water penetration due to its denser structure as WSA performed as filler material [13].

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II. MATERIALS

Lucky Star cement were used for this research work. Fine aggregates used were bolhari hill sand and coase aggregate used were collected from petaro, a site near Jamshoro. Wheat straw Ash was collected after burning wheat straw at uncontrolled temperature. The resulting ash was passed from #200 sieve.

Fig. 1: Wheat Straw Ash

Fig.2: Coarse Aggregates

Fig.3: Fine Aggregates

III. RESULTS

A. *Compressive Strength of Concrete*

The compressive strength test was performed on concrete cubes of size 100mm×100mm×100mm by replacing cement with WSA. The cement replacement percentages were 0%, 5%, 10%, 15% and 20% by weight of cement. For each replacement level three cubical specimens were cast, cured and tested at curing ages of 7, 28 and 90 days. The average value of three specimens was taken as final strength. The compressive strength was found maximum at 10% cement replacement and minimum at 20% replacement level. The final results are shown in Fig.02.

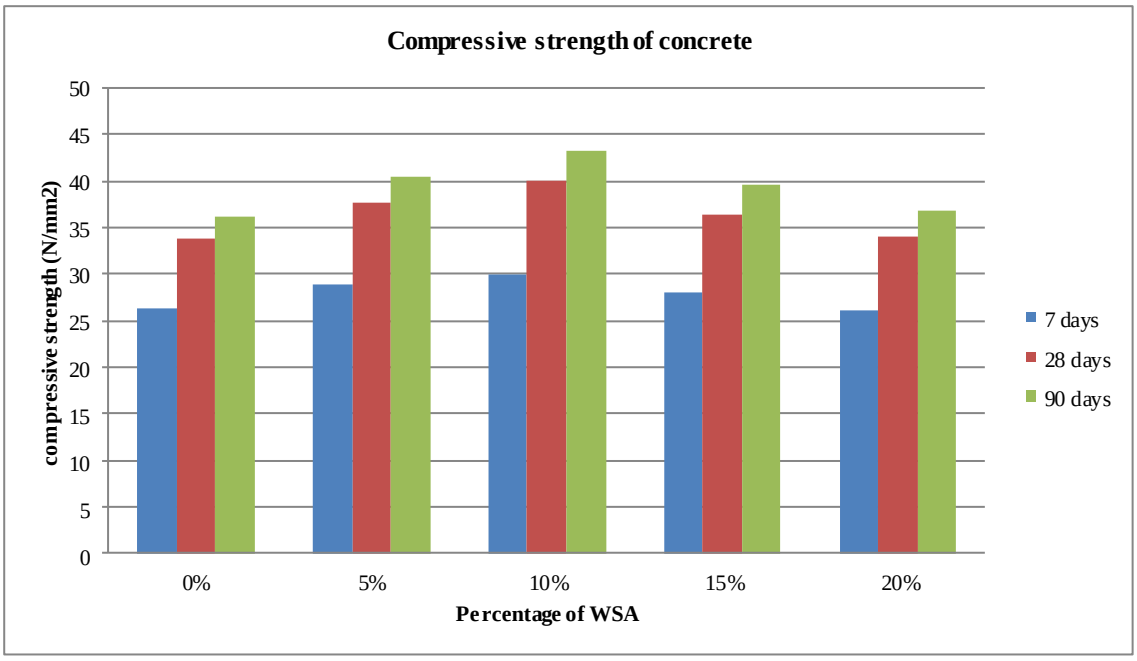

Fig.01: Compressive Strength of Concrete

IV. CONCLUSIONS

The replacement of cement with WSA in concrete enhances the compressive strength of concrete, while reduces workability of concrete, due to the fineness of WSA particles as compared to cement particles.

The maximum compressive strength was determined at 10% replacement level, whereas minimum compressive strength was observed at 20% replacement. The reason for this is that up to 10% replacement level WSA fills all the voids left in the concrete composite and forms a dense concrete of more strength.

V. RECOMMENDATIONS

The overall research proposes that the use of wheat straw ash increases compressive strength however reduces the workability to a larger extent; while used engine oil increases workability to a smaller extent, meanwhile reduces compressive strength. Therefore, an advanced research study may be needed in the future to increase the workability of WSA concrete with different mineral and chemical admixtures.

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