Effect on Structural characteristics of Concrete with Waste and Recycled Material – A Review

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Abstract: Reuse of recycled or waste materials for the construction of civil structures is an issue of great importance in this century. Use of waste materials in construction industry reduces the consumption of Portland cement per unit volume of concrete. OPC has large energy utilization and emanation related with its manufacture, which may be decreased by substituting cement partially with waste products. Mixing of mineral admixtures in concrete and mortar improves compressive strength and characteristics of concrete.

The emphasis of researcher is to review the research works investigating the suitability of waste or recycled materials as construction materials with Fiber Reinforced Plastic laminated steel bars.

I. INTRODUCTION

When structures made of concrete are demolished or renovated, concrete recycling is an increasingly common method of utilizing the rubble. Concrete was once routinely trucked to landfills for disposal, but recycling has a number of benefits that have made it a more attractive option in this age of greater environmental awareness, more environmental laws, and the desire to keep construction costs down. Some of the materials, known as Pozzolana, which by themselves have no cementitious properties, though, when added with Ordinary Portland cement reacts to form cementitious materials. Fractional replacement of Portland cement in concrete decreases the quantity of Portland cement. This decrement in cement quantity further reduces the construction cost, energy loss and waste emissions such as carbon dioxide (CO2) emission. This also, reduces the energy consumption and thus, reduces the rate of global warming.

II. CONCRETE COMPOSED OF WASTE MATERIALS

Cement production is an energy exhaustive procedure which also has a vital consequence on the environment. Manufacturing one ton of ordinary Portland cement discharges around one ton of carbon-dioxide gas into environment and as a result of this creation 1.6 billion tons of carbon-dioxide is released every year which is expected at about 7% of the carbon-dioxide making worldwide. The demands of environmental constraints and environmental instructions must increase in the future which will direct for increased use of supplementary cementitious materials. Important reasons behind the increased use of supplementary materials in cement concrete are

1. To reduce the consumption of cement though replacing the cement with materials having cementitious properties.
2. To improve the properties of fresh and hardened concrete. Recently, several researchers produced high performance concrete by reducing water/cement ratio through the application of super-plasticizers and ultrafine mineral admixtures.

Concrete composed by partially replacing cement with industry wastes are termed are green cement. This developed green cement is put side by side with ordinary Portland cement by many investigators. This “green” material makes less use of natural resource, energy and releases less CO_2. Various concrete mixes are composed of using theses admixtures such as – light weight concrete (LWC) and high performance concrete.

2.1 Light weight concrete

Fly Ash (FA) and furnace bottom ash (FBA) are two waste materials from coal-fired thermal power plants. They are, relatively, lighter than traditional coarse aggregate, OPC and natural sand. Concrete mix developed using these materials are having low weight. The utilization of light weight concrete as a substitute of concrete can significantly reduce the dead load of structural members, which makes it particularly attractive in multi-storey buildings and permits greater design flexibility by substantial cost savings and reducing dead load.

2.2 High performance concrete

American Concrete Institute defines HPC as a specially engineering concrete, having more than one specific characteristics of which have been enhanced through the selection of component materials and mix proportions. These materials are also known as 21st century concrete, are characterized by improved mechanical and durability properties resulting from use of chemical and mineral admixtures as well as specialized production processes.

High Performance Concrete (HPC) comprises reused materials such as fly ash, blast furnace slag and silica fume. HPC offers increased strength and durability properties and contributes towards long lasting pavements and structures. The construction ability may also be improved by proper mixture proportioning and testing.

Concrete aggregate collected from demolition sites is put through a crushing machine. Crushing facilities accept only uncontaminated concrete, which must be free of trash, wood, paper and other such materials. Metals such as rebar are accepted, since they can be removed with magnets and other sorting devices and melted down for recycling elsewhere. The remaining aggregate chunks are sorted by size. Larger chunks may go through the crusher again. After crushing has taken place, other particulates are filtered out through a variety of methods including hand-picking and water flotation.

Crushing at the actual construction site using portable crushers reduces construction costs and the pollution generated when compared with transporting material to and from a quarry. Large road-portable plants can crush concrete and asphalt rubble at 600 tons per hour or more. These systems normally consist of a rubble crusher, side discharge conveyor, screening plant, and a return conveyor from the screen to the crusher inlet for reprocessing oversize materials. Compact, self-contained mini-crushers are also available that can handle up to 150 tons per hour and fit into tighter areas. With the advent of crusher attachments - those connected to various construction equipment, such as excavators - the trend towards recycling on-site with smaller volumes of material is growing rapidly. These attachments encompass volumes of 100 tons/hour and less.

III. LITERATURE REVIEW

Many studies have been done to discover the benefits of using pozzolanic materials in increasing the properties of concrete. The renovation from a conservative consumption based society to a sustainable society is immediately vital worldwide due to the contamination of the natural environment, the exhaustion of the natural assets and the falling capability of the final desecrate disposal facilities. Presently, the construction industry contributed 19% of the total quantity of industrial removal, which alarms a call for reprocess to guard the surrounding environment. In particular, reusing of construction waste is an essential subject to be encouraged.

Many works have been done to explore the benefits of using pozzolanic materials in making and enhancing the properties of concrete. Thomas and Shehata [1] have studied the ternary cementitious blends of Portland cement, silica fume, and fly ash offer significant advantages over binary blends and even greater enhancements over plain Portland cement. Sandor [2] have studied the Portland cement-fly ash – silica fume systems in concrete and concluded several beneficial effects of addition of silica fume to the fly ash cement mortar in terms of strength, workability and ultra sonic velocity test results.

The enhancement of concrete technology can minimize the consumption of normal assets and energy sources which diminish or destroy the burden of pollutants on the surroundings. At the moment, huge extent of marble powder have been generated in ordinary stone processing plants with an critical collide on the ambiance and life (Aalok and Sakalkale) [3]**.**

Lam, Wong, and Poon [4] in their studied entitled Effect of fly ash and silica fume on compressive and fracture behaviors of concrete had concluded enhancement in strength properties of concrete by adding different percentage of fly ash and silica fume.

Replacement of sand with waste powder as a fine aggregate in concrete draws severe awareness of researchers and investigators. The utmost compressive and flexural strengths were experimented for specimens containing a 6% dissipate mud when compared with ordinary mix and it has been also instigate that mixing of waste powders up to 9% could efficiently be used as a preservative material in civil materials (Singh and Nanda)[5].

With the addition of obtained waste marble powder the characteristics of concrete steadily increases up to certain bound. With the addition of Marble powder early strength increase in concrete is elevated. It has been revealed that the best percentage for substitution of marble powder with cement and it is approximately 10% binder for both casted cubes and cylinders (Valeria et al.) [6].

According to Hendriks and Janssen (2003) [7] there are numerous alternatives for the reuse of recycled materials in structures. For each alternative a number of scientific and environmental aspects are applicable. Also, explains numerous models which can be utilized to take the optimal assessment. In common the world-wide used Life Cycle Assessment can be applied as a multi-parameter model for the ecological effects.

Khari et al. (1995) [8] explained that minimum essential mixing time has been determined from the development of the power applied to the tool during mixing. It has been concluded that high w/c values resulted in short stabilization times. In addition, the contents of silica fume and quartz flour as well as the type of cement and super plasticizer affected the stabilization time considerably.

Concrete prepared using recycled aggregates have been used for many years in several countries which go ahead the way in this concept (Kwan et al., 2012) [9]. Many major projects have been completed in these countries with cheering results. Its utilization is so widely spread worldwide, so, that several countries have adopted it and are preparing regulatory documents about its use.

Application of fine recycled aggregates in concrete improves the properties of cement concrete. Several researchers determined effect over most vital properties of concrete compressive and tensile strength; modulus of elasticity; water absorption; shrinkage; carbonation and chloride penetration. For the long-term durability of reinforced or pre-stressed concrete carbonation and chloride penetration are significant properties. Experiments have been performed by preparing concrete mixes with different rates of substitution of fine aggregates with fine recycled aggregates obtained from crushed concrete. Testing results had been compared with concrete of same mix proportions without any recycled aggregates.

Reuse of waste materials from construction industry is a creative step towards sustainable and green construction (Uygunoğlu, 2011)[10].

Usage of waste materials in construction has been considered as good thought; however, this thought has been not accepted widely between the researchers. But, through proper concrete mix design the concrete having recycled aggregate can achieve target strength and is appropriate for broad variety of applications in construction. Good knowledge regarding durability and properties influencing durability is required for applying recycled aggregate in construction.

Pacheco-Torgal and Jalali S, 2011[11] presented important information over the robustness and design methodology for recycled aggregates. Parameters investigated in this study are compressive strength, ultrasonic pulse velocity, shrinkage, water absorption and intrinsic permeability. It has been observed from results that the in recycled aggregates concrete ultrasonic pulse velocity is higher, and it contains low water absorption intrinsic permeability. By replacing 80% of the total coarse aggregate with recycled aggregates and by following mix design method proposed by the Department of Environment, target crushing strength can be achieved.

Radlinski, Olek and Nantung [12] in their experimental work entitled effect of mixture composition and Initial curing conditions on the scaling resistance of ternary concrete have find out effect of different proportions of ingredients of ternary blend of binder mix on scaling resistance of concrete in low temperatures.

Barbhuiya, Gbagbo, Russeli and Basheer [13] studied the properties of fly ash concrete modified with hydrated lime and silica fume concluded that addition of lime and silica fume improve the early days compressive strength and long term strength development and durability of concrete.

Accumulation of waste marble dust in cement has been presented by Aliabdo [14], in this work cement mortar and concrete composed by applying marble dust have been found to be improved, with the addition of marble dust. Concrete composed adding of marble dust as replacement of sand reveals improved act compared to replacement of cement. The chief idea of this investigation has been found to be examine the opportunity of utilizing waste marble dust in cement and concrete making.

The usefulness of waste marble dust as preservative material combine together with cement is examined by Aruntaş et al. [15]**.** For this plan, waste marble dirt added cements were attained by inter blending with marble dust with Portland cement ashes at dissimilar combine ratios at different percentages by weight. Standard cube size of mortar prisms has been artificial with the obtained cements. On these mortar prisms, strength tests have been accepted sample on different days of curing.

Emre and Şükrü in 2015 [16] examined the blended cements produced by using the building stone powder were out to sulfate concentration for unusual properties. Prepared mortar specimens had been cured under water for 28 days and then exposed to several different extents of sodium sulfate solution for large number of days. Performances of cements had been determined by testing properties like compressive and tests. In mixed binders exclusively cements produced by substituting waste provides like strength data when compared with ordinary Portland cement at the ages of different curing days.

Shayan and Xu (2006) [17] studied the presentation of glass powder in concrete in the real situations, a field examination has been performed by means of a 40 MPa concrete combination, including and considering a range of proportions of glass powder in and as cement replacement. Several blends were formed and most of the mixtures also involves sand-size meshed glass collective substance, were used to cast several concrete slabs. Concrete casted has been tested for the compressive and separating tensile strength, shrink and rise, ultrasonic pulse velocity, and permeability of chloride. Basic models had been cut from the slabs of various life spans for the same as well as for micros assessment. Mixtures with glass powder blend showed acceptably when compared in drying shrinkage and alkali reactivity. The outcomes revealed that GLP can be incorporated into high strength concrete at considerable proportions such as 20 – 30% to substitute of cement. Application of glass powder provides for substantial well utilization of waste glass in prepared mixes and noteworthy changes in the production of harmful gases to environment. .

Mehmet (2014) [18] discussed the result of chemical over few good strength gains of mixed cement mortars in

order to expand a enhanced consideration for enhancement of hydration and strength of newly mixed cements. Pastes and mortars, containing the mixed blends and the ordinary cement had been also formed and they had been cured within water to pending tests. Experimentations including test of chemical compositions of mixtures and strengths after different curing periods have been performed according to standard codes.

Xianwei and Zhenyu [19] have been investigated the causes of ground waste concrete powder, impending from the close mix, on water requirement for normal characteristics of concrete. The results presented that the 20% of waste powder to the weight of mix cement has modest consequence on the normal tested properties.

IV. DISCUSSION AND CONCLUSIONS

From present literature review it has been observed that, high use and production of Portland cement as the major construction material in concrete construction affects the environment by creating large amount of CO_2 gas also there is a direct relationship between cement usage and Green house gas production. Many studies have tried to find a way to minimize the use of Portland cement to reduce these problems without increasing construction cost. Partial replacement of Portland cement by supplementary cementitious materials is one such method and with a proper amount of replacement, it has the benefit of improving the properties of concrete, reducing costs, conserving energy and minimizing waste emission.

V. REFERENCES

[1]. Thomas , M. D. A. and Shehata, M. H. " Use of ternary cementitious systems containing silica fume and fly ash in concrete "; cementand concrete research 29 (1999).

[2]. Sandor, P. "Portland Cement- Fly ash- Silica fume Systems in concrete "Department of civil and Architectural Engineering, Drexel University, Philadelphia, Pennsylvania.

[3]. Aalok and Sakalkale D."Experimental Study on Use of Waste Marble Dust in Concrete" Int. Journal of Engineering Research and Applications Vol. 4, Issue 10(Part -6), October 2014, pp. 44-50.

[4]. Lam, Wong, and Poon "Utilization of Fly Ash, Rice Husk Ash, and Palm Oil Fuel Ash in Glass Fiber–Reinforced Concrete"J. OF MAT. IN CIVIL ENGG. , Sep. 2012, P. 1281 -1288.

[5]. Singh T. and Nanda A. K. "Influence of Marble Powder on Mechanical Properties of Mortar and Concrete Mix"NMBCW June 2012

[6]. Valeria Corinaldesi, Giacomo Moriconi, Tarun R. Naik, Characterization of marble powder for its use in mortar and concrete, Construction and Building Materials, Volume 24, Issue 1, January 2010, Pages 113-117, ISSN 0950-0618,

[7]. Hendriks Ch. F. and G. M. T. Janssen "Use of recycled materials in constructions" Materials and Structures , November 2003, Volume 36, Issue 9, pp 604-608.

[8]. **Khatri R.P., Sirivivatnanon V. and Gross W. "**Effect of different supplementary cementitious materials on mechanical properties of high performance concrete" Cement and Concrete Research, Volume 25, Issue 1, January 1995, P. 209-220

[9]. Kwan W.H., Ramli M., Kam K.J. and Sulieman M.Z. "Influence of the amount of recycled coarse aggregate in concrete design and durability properties" Construction and Building Materials 26 (2012) 565–573.

[10]. Uygunoğlu T., "use of hydrated mortar as partial replacement material in cement", Advances in Cement Research, Volume 23, Issue 3, May 2011 P. 113 –122.

[11]. Pacheco-Torgal F., Jalali S. "Compressive strength and durability properties of ceramic wastes based concrete" Materials and Structures (2011) 44:155–167.

[12]. Radlinski, Olek and Nantung "Durability performance of concrete made with fine recycled concrete aggregates" Cement & Concrete Composites 32 (2010) 9–14.

[13]. Barbhuiya, S. A., Gbagbo, J. K., Russell, M. I., & Basheer, P. A. M. (2009). Properties of fly ash concrete modified with hydrated lime and silica fume. *Construction and Building Materials*, *23*(10), 3233-3239.

[14]. Aliabdo Ali A., Elmoaty Abd, Elmoaty M. Abd, Esraa M. Auda " Re-use of waste marble dust in the production of cement and concrete". Construction and Building Materials, Volume 50, 15 January 2014, Pages 28-41, ISSN 0950-0618.

[15]. Aruntaş H. Y., Gürü M., Day M., and I. Tekin, "Utilization of waste marble dust as an additive in cement production," Materials and Design, vol. 31, no. 8, pp. 4039–4042, 2010.

[16]. Emre Sancak and Şükrü Özkan, "Sodium Sulphate Effect on Cement Produced with Building Stone Waste," Journal of Materials, vol. 2015, Article ID 813515, 12 pages, 2015. doi:10.1155/2015/81351

[17]. Shayan and Xu (2006) "Performance of glass powder as a pozzolanic material in concrete: A field trial on concrete slabs" Cement and Concrete Research 36 (2006) 457–468.

[18]. Mehmet Serkan Kirgiz, "Effects of Blended-Cement Paste Chemical Composition Changes on Some Strength Gains of Blended-Mortars," The Scientific World Journal, vol. 2014, Article ID 625350, 11 pages, 2014. doi:10.1155/2014/625350

[19]. Xianwei Ma and Zhenyu Wang, "Effect of Ground Waste Concrete Powder on Cement Properties," Advances in Materials Science and Engineering, vol. 2013, Article ID 918294, 5 pages, 2013. doi:10.1155/2013/918294.