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Flexural Study on Reinforced High Performance Concrete Beams: A Review

Mohit, Neetu

Structural Engg, MRIEM, Rohtak, India

ABSTRACT: The purpose of this study was to develop a methodology for using industrial by-products on the strength properties, durability characteristics, and flexural behavior of load carrying capacity of reinforced HPC beam elements and, as a result, to increase the strength when compared to the strength of conventional concrete. In order to make high-performance concrete, the cement, fine aggregate, and coarse aggregate are often substituted by silica fume, bottom ash, and steel slag aggregate respectively. In the next part, this paper will find a synopsis of the research that was conducted in order to arrive at such a formulation, as well as the findings.When making high-performance concrete, one of the most common practices now being used is the utilization of industrial by-products. To improve the overall performance of the concrete, ingredients such as silica fume, bottom ash, and steel slag aggregate are used. This research study demonstrates a technique for incorporating by-products of industrial processes into the production of concrete. Research is done on both the physical characteristics of specific gravity and the chemical qualities of all possible combinations.

KEYWORDS: Industrial By-Products, Flexural Behavior, Reinforced HPC Beam, High-Performance Concrete

I. INTRODUCTION

Concrete is undoubtedly the most extensively utilized construction material for all types of activity in the building industry worldwide, and it will stay so for the foreseeable future. Concrete's appeal stems from the raw material's superior strength and durability, inexpensive production and maintenance costs, adaptability in molding diverse shapes, and its limitless structural applications in conjunction with steel structures. Nonetheless, the building industry faces a significant issue due to the importance of cement. Cement manufacture is an energy-intensive operation, and the emission of large amounts of carbon dioxide during cement production contributes to global warming. Cement causes anguish in concrete under hostile environmental circumstances nowadays. As a result, there is a need to reduce cement usage and increase research into the possibilities of improving strength and durability qualities through the use of mineral admixtures. Many poor countries are working on producing alternative building materials based on local elements. The use of extra cementitious ingredients or mineral admixtures for making high performance concrete has been one of the key trust areas of concrete research. Concrete is undeniably the most widely utilized construction material for all types of activity in the building industry worldwide, and it will stay so for the foreseeable future. Concrete's appeal stems from the raw material's superior strength and durability, inexpensive production and maintenance costs, adaptability in molding diverse shapes, and its limitless structural applications in conjunction with steel structures. Nonetheless, the building industry faces a significant issue due to the importance of cement. Cement manufacture is an energy-intensive operation, and the emission of large amounts of carbon dioxide during cement production contributes to global warming, and cement causes anguish in concrete under hostile environmental circumstances nowadays. As a result, there is a need to reduce cement usage and increase research into the possibilities of improving strength and durability qualities through the use of mineral admixtures. Many poor countries are working on producing alternative building materials based on local elements. The use of extra cementitious ingredients or mineral admixtures for making high performance concrete has been one of the key trust areas of concrete research.

The use of mineral admixtures and industrial by-products such as fly ash, silica fume, metakaolin and Ground Granulated Blast Furnace (GGBS)is to conquer the inimical effect of calcium hydroxide. These mineral admixtures produce less percentage of calcium hydroxide when compared to ordinary Portland cement. Their use in concrete, to replace cement, partially conserves cement and power, improves strength, durability and helps to protecting the environment. So far, the production of high-performance concrete with these supplementary materials is highly recommended by the researchers. Investigations divulged that many industrial by- products can be used to replace the concrete materials to improve the economic condition and minimize the construction cost.

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Aggregates are considered one of the important constituents of concrete since they occupy more than 70% of the concrete mix. Generally, the river sand is used as fine aggregate in concrete and it is obtained by mining the sand from river bed. In order to do this, mining not only affects the aquifer of the river bed but also causes environmental problems. The utilization of industrial by-products or secondary materials has encouraged the production of cement and concrete in construction industry. New industrial by-products and secondary materials are generated by various industries. Concrete prepared with such materials showed improvement in workability, mechanical property and durability when compared with conventional concrete. Over recent decades, intensive research studies have been carried out to explore all possible reuse and by-products such as waste foundry sand (WFS), coal bottom ash (CBA), cement kiln dust (CKD) and wood ash (WA) in making cement- concrete and controlled low-strength material (CLSM).High consumption of natural sources and high amount production of industrial by-products and environmental pollution require obtaining new solutions for a sustainable development.

CONCRETE

In construction field applications, concrete is required to meet certain specific performance need to enhance high strength and high durability characteristics. When the general performance of concrete is substantially higher than that of conventional concrete, such concrete is referred to as high performance concrete (HPC). However, from a strength point of view, usually high strength, high durability which is regarded as the most favourable factors of being a construction material, are the key attributes to produce the HPC. So, the need for the requirement of high mechanical properties and durability properties has made the researchers find out the appropriate technology through research, and the HPC was the outcome. The HPC can be referred to as a concrete, made with suitable materials (supplementary cementitious materials, chemical admixtures, industrial by-products, etc) combined according to a selected mix design and properly mixes, transported, placed, consolidated and cured to give excellent performance in some properties of concrete, such as high compressive strength, high density, low permeability, and good resistance to certain forms of chemical attack.

ADMIXTURES AND BY-PRODUCTS

Over decades, attempts have been made to obtain concrete with certain desired characteristics such as high compressive strength, high workability, and high performance and durability parameters to meet the requirement of complexity of creating structures. A material other than water, aggregates, or cement is used as an ingredient of concrete to control setting and early hardening, workability, or to provide additional properties. The use of mineral admixtures such as fly ash, silica fume, metakaolin, GGBS is to conquer the adverse effect of calcium hydroxide produced during hydration of cement in concrete. In concrete, the consumption of calcium hydroxide improves the durability of concrete which can make concrete dense and impervious at the time of pozzolanic reaction when mineral admixtures are added. Hence, the mineral admixtures in optimum proportion improve the quality of concrete by Lowering the heat of hydration and thermal shrinkage

- Increasing the water tightness
- Reducing the alkali-aggregate reaction
- Improving the chemical resistance
- Improving the corrosion resistance
- Improving the early strength, workability and extensibility
- Improving the rate of strength development

A pozzolan is a material which, when combined with calcium hydroxide (lime), exhibits cementitious properties. Pozzolans are commonly used as an addition to Portland cement concrete mixtures to increase the long-term strength and other material properties and in some cases reduce the material cost of concrete. Ground granulated blast-furnace slag is the granular material formed when molten iron blast furnace slag (a by-product of iron and steel making) is rapidly chilled (quenched) by immersion in water. It is a granular product, highly cementitious in nature and, ground to cement fineness, hydrates like Portland cement. The finely divided residue resulted from the combustion of ground or powdered coal. Fly ash is generally captured from the chimneys of coal-fired power plants; it has pozzolanic properties, and is blended with cement for this reason. Pozzolanic reaction occurs between silica fume and the Calcium hydroxide (CH), producing additional calcium silicate hydroxide (CSH) in many of the voids around hydrated cement particles. This additional CSH provides the concrete with not only improved compressive, flexural and bond- strength but also a much denser matrix, mostly in areas that would have remained as small voids subject to possible ingress of deleterious materials.

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The terms condensed silica fume, micro silica and volatilized silica are often used to describe the by-products extracted from the exhaust gases of silicon, ferrosilicon and other metal alloy furnaces. However, the terms micro silica and silica fume are used to describe those condensed silica fumes that are of high quality, for use in the cement and concrete industry. Rice Husk ash is a bio waste from the husk left from the grains of rice. It is used as a pozzolanic material in cement to increase durability and strength. When admixtures are added to concrete, it requires chemical admixture such as super plasticizer for maintaining workability of concrete. The use of super plasticizer has become almost a universal practice to reduce w/c ratio for the given workability, which naturally increases the strength. Moreover, the reduction in w/c ratio improves the durability of concrete. There is more recent and more effective type of water reducing admixtures used in concrete in terms of high range water reducers. Industrial by-products used for alternative for aggregates are marble dust, quarry wastes, coir wastes, recycled aggregates, polystyrene, plastic wastes, bottom ash, shredded tires, glasscrete, steel slag aggregate, coconut shells, etc.

High consumption of natural sources, high amount of production of industrial by- products and environmental pollution are some of the factors which are responsible for obtaining new solutions for a sustainable development. Thus, the solution is utilization of Industrial by-products such as bottom ash, waste foundry sand, steel slag aggregate and waste glass in producing concrete. These concrete technologies reduce the negative effects on economic and environmental problems of concrete industry by having low costs, high durability properties and environmental friendliness. As a result, the use of the following by-products has been proposed as replacement for cement and aggregates for concrete such as silica fume, bottom ash and steel slag aggregate.

II. BACKGROUND

This section provided a brief assessment of the literature on the impact of industrial by-products in concrete on the strength, durability, and flexural behaviour of reinforced concrete beams. Here is a full examination of industrial by-products utilized in concrete mix design, the properties and role of silica fume, bottom ash, and steel slag aggregate, durability, flexural behaviour features, ANN modelling, NDTinvestigation on concrete. The literature on the behaviour of reinforced high performance concrete beams with ANN modelling was reviewed.

The high performance concrete mix proportioning approach simply provides a starting mix design that must be changed to match the desired concrete properties. Investigated the mix design for ternary blended high strength concrete incorporating metakaolin and silica fume by combining BIS and ACI code mix design methods and testing experimentally for compression, split tension, flexure, and workability and concluded that the designed mixes performed very well Studied a simplified mix proportioning method for high performance concrete with experimental study on rheological, hardened and durability characteristics of HPC mixes. The influence of parameters such as cement content, micro-silica addition, superplasticizer dosage and water powder ratio was identified. A simplified mix proportioning method for an economic variant of HPC, with slump higher than 190mm, early strength greater than 50 N/mm2, later age strength 90 to 125 N/mm2 and very low values of water absorption, sorptivity and chloride permeability was proposed.

Magda, (2015) conducted an experimental program to investigate the flexural behaviour of concrete beams with variable length of tension reinforcement lap slice and 18 simple beams containing different lap slice length and the parameters included in the experimental program are the splice length, the bar diameter, the amount of transverse reinforcement provided within the splice zone, the shape of the anchor at the splices end and the concrete cover.

Magda, (2015) investigated the concrete containing silica fume which showed high resistance to fire with increasing silica fume upto 20% replacement of cement. The concrete mix produced with a cement content of 500 kg with 0.3 w/b ratio, cement was replaced by 0%, 10%, 15% and 20% by silica fume and it was found that the compressive strength increased with increasing temperature.

Eehab and Mohamed, (2014) developed fly ash and silica fume based high performance concrete mixes and found significant improvements in the property of fresh and hardened concrete.

Dalila et al, (2014) reported that among the various mineral additives used in concrete structures, the silica fume was highly preferred for its superior concrete durability properties. The influence of silica fume on deformability is more than that on compressive strength. It consisted of development and the mechanical and elastic properties of a concrete

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with high performance concrete starting from materials existed and to study the influence of additions on the deformability of concrete. The sulphate resistance of concrete containing silica fume was good, partly because of lower permeability.

Magudeaswaran and Eswaramoorthi, (2013) developed an experimental study on durability characteristics of high-performance concrete with partial replacement of cement by fly ash and silica fume in the level of 12.5%, 15%, and 17.5%. It was observed that for the increase in the percentage of fly ash and silica fume, there was steady increase in the water absorption and alkalinity which significantly indicates the markable change in strength and durability characteristics of concrete.

Karthikeyan et al, (2013) presented creep and shrinkage data from an experiment on high performance concrete (HPC) and were compared with eight models, with the aim to identify the good predictor model for the local environmental conditions.

Wang and Li, (2013) studied a detailed presentation of experimental method for autogenous shrinkage of high-performance concrete with various w/c ratios. The replacement ratio of fly ash and silica fume was used for making high performance concrete and it showed that the autogenous shrinkage increases as the w/c ratio decreases.

Aleksandrs et al, (2013) reported that the partial replacement of cement by silica fume improved the influence of cavitations treatment of small dispersed raw materials on the compressive strength properties of produced concrete. They concluded that average compressive strength of concrete increased from 2.3% to 6.5% for both types of considered designed mixes with different w/c ratios.

Kadam and Patil, (2013) suggested that the effect of coal bottom ash as sand replacement on the properties of concrete with different w/c ratio and bottom ash was replaced by 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100% by weight as water absorption of bottom ash was more so that quantity of water was increased to achieve 100 mm slump. The results showed that the compressive strength, split tensile strength and flexural strength decreased as the percentage of replacement coal bottom ash increased as compared to controlled concrete.

Mathiraja, (2013) revealed that the mechanical properties of concrete using bottom ash manufactured sand and metallic fibres for production of high-performance concrete and dealt about the workability of high performance concrete made with fibre showed reduction in workability. The compressive strength of concrete with 20% bottom ash containing 37.42 MPa showed better strength when compared to other mixes.

Diana et al, (2013) conducted an experimental study of concrete with coal combustion bottom ash as microfiller with pozzolanic properties. Coal combustion bottom ash can be effectively replaced by cement up to 20% of its total amount without reducing compressive strength of concrete. They concluded that the research results approved that coal combustion bottom ash has little pozzolanic activity based on properties of bottom ash.

Purushothaman and Senthamarai, (2013) investigated the experimental program of effect of bottom ash on the strength properties of high-performance concrete and found compressive, tensile and flexural strengths development for the concrete ages of 7, 28, 56 and 90 days and the results were compared with conventional concrete. They concluded that the incorporation of 10 % silica fume and 40 % bottom ash in concrete results in significant improvements in its mechanical properties of bottom ash concrete compared to the control mix and it should be noted that further research work is needed to explore the effect of bottom ash as fine aggregates on the durability properties of concrete.

Abul and Ibrahim, (2013) showed that steel-fiber reinforced ultra-high-performance concrete had flexural tensile strength exceeding 30 MPa and test results showed that high performance concrete bars function adequately developing flexural tensile strength of about 30 MPa at the peak load without any bond slip and the beams showed post-peak load ductility with softening in which deflection increases with progressive reduction in residual strength.

Wasan and Tayfur, (2013) studied the flexural strength of fibrous ultra-high performance reinforced concrete beams of eleven containing hooked and crimped steel fibers with different volume fractions in full and partial depths of beams cross sections, and parameters like load deflection relationship, resilience, toughness indices, first crack load, ultimate load and concrete strains were investigated. They concluded that calculated ultimate moment capacity was in good

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agreement with the experimental ultimate moment capacity.

Purushothaman and Senthamarai, (2012) presented the experimental investigation on the effective use of bottom ash obtained from thermal power station as a replacement of fine aggregates and silica fume as a replacement of cement on the properties of high-performance concrete. The investigation revealed that the combined use of industrial wastes silica fume and bottom ash improved the mechanical property of high-performance concrete which is otherwise hazardous to the environment and thus these two materials may use as a partial replacement material for making high performance concrete.

Yoo et al, (2012) expressed autogenous shrinkage in High performance concrete with w/c ratio 0.3 with mineral admixtures fly ash 0%, 10%, 15%, 20% & 30% and silica fume 0%, 5%, 7.5%, 10% & 15% and chemical admixture shrinkage reducing agent and expansion agent. They concluded that the autogenous shrinkage in high performance concrete with fly ash decreased continuously with larger fly ash replacement and silica fume increased when compared to that in OPC concrete and they explained that both of these admixtures in adequate amount decreased in autogenous shrinkage as well as improvement of the strength.

H.Yang and C.Joh (2011) The purpose of this paper is to examine the basic behavior of ultra-high strength concrete beams reinforced with steel fibers. The experimental parameters included steel rebar ratio less than 0.02 and the method of placing ultra-high-performance concrete. The ultra-high strength concrete did not use coarse aggregate and had a volumetric ratio of 2%. The experimental test results from static loading of the beams revealed the characteristics of flexural behavior of the steel fiber-reinforced ultra-high strength concrete. Flexural behavior included cracking, failure pattern, deflection, ductility, and flexural strength measurements. The test results from this study provide more information to help establish a prediction model for the flexural strength and deflection of ultra-high strength concrete beams under bending conditions.

Saaid et al, (2011) studied the flexural behavior of reinforced high performance concrete beams made with steel slag coarse aggregate and total of eight under, balanced and over reinforced beams which were fabricated and tested. Data presented concentrated on the chemical, physical and mechanical properties of the steel slag coarse aggregate and the flexural behaviour of reinforced HPC beams. They concluded that steel slag concrete beam showed good ductility behaviour with tension reinforcement ratio up to 3.6%.

Yang et al, (2011) carried out an experimental investigation on basic behaviour of ultra high strength concrete beams reinforced with steel fibres having steel rebar ratio less than 0.02 and the method of placing ultra high performance concrete. The results also exhibited the flexural behaviour included cracking, failure patter, deflection, ductility and flexural strength measurements and the test results provided more information to help establish a prediction model for the flexural strength and deflection of ultra high strength concrete beams under bending conditions.

Elahi et al, (2010) presented an investigation of mechanical and durability properties of high performance concrete containing w/c ratio 0.3 which used supplementary cementitious materials such as silica fume, fly ash, ground granulated blast furnace slag in binary and ternary systems. Portland cement was used with fly ash upto 40% and silica fume upto 15% and GGBS was replaced upto 70% performed the best amongst all the mixes to resist the chloride diffusion. An experimental investigation on the flexural behaviour of reinforced high-performance concrete was conducted by Kumar et al, (2008) using crushed stone sand replaced by fine aggregate and coarse aggregates in addition to silica fume and fly ash combination with superplasticizer.

Jieying et al, (2008) presented a maturity concept and approach of applying the maturity method for predicting the development of mechanical properties of high-performance concrete over time. And this concept makes the maturity approach more robust and more general for application to different concrete mix formulations and different types of property.

Aggarwal et al, (2007) proved that the effect of bottom ash as replacement of fine aggregates in concrete from 0 to 50% ranges developed compressive strength, flexural strength and splitting tensile strength easily equated to the strength development of normal concrete at various ages.

Venkatesh et al, (2005) proposed the mix proportioning of high-performance silica fume concrete using response surface methodology. The four key mixture constituents used in the models included cement, silica fume and high range water reducer and water binder ratio and modelled response that included compaction factor, compressive strength, split tensile strength and flexural strength at 28 days and finally derived models were valid for a wide range of mixtures with range of water binder ratio of 0.28-0.44, cement content of 400 to 600 kg/m3, silica fume 0 to 10% (by weight of mass cement) and HRWR dosage of 1 to 3% (by weight of mass cement).

Muhammad et al, (2005) conducted an expert system for mix design of high-performance concrete with selecting proportions of mixing water, cement, supplementary cementitious materials, aggregates and superplasticizer, considered the effects of air content as well as water contributed by superplasticizer and moisture conditions of aggregates.

Bai et al, (2005) investigated the strength and drying shrinkage properties of concrete containing furnace bottom ash as fine aggregate at 0, 30, 50, 70 and 100% by mass at fixed w/c ratios and fixed slump ranges. They concluded that 30% of bottom ash was beneficially replaced by fine aggregate to produce concrete in the compressive strength range from 40 to 60 N/mm2 without detrimentally affecting drying shrinkage properties of the concrete.

Bharatkumar et al, (2001) proposed a mix proportioning method to obtain strength to effective w/b ratio relationship for a given set of materials and for the same workability for the HPC with fly ash and ground granulated blast furnace slag, and when mineral admixtures significantly depend on the properties of mineral admixtures and with the characteristics of concrete mixes.

III. CONCLUSION

This research aimed to formulate a methodology for using industrial by-products on the strength properties, durability characteristics and flexural behavior of load carrying capacity of reinforced HPC beam elements and hence to enhance the strength when compared to the conventional concrete. The silica fume, bottom ash and steel slag aggregate are used to replace the cement, fine aggregate and coarse aggregate to produce high performance concrete. The summary of the works leading to such a formulation together with the conclusions are given in the subsequent section.

The use of industrial by-products is becoming more popular for producing high performance concrete. Silica fume, bottom ash and steel slag aggregate are introduced to enhance the overall performance of concrete. This research study represents a method of using industrial by-products for producing concrete. The physical properties of specific gravity and chemical properties of all combinations are studied.

REFERENCES

1. Aggarwal, P., Aggarwal, Y., and Gupta, S.M., (2007), Effect of Bottom ash as replacement of Fine aggregates in concrete, Asian Journal of Civil Engineering (Building and Housing), Vol.08, No. 01, pp.49-62.
2. Abul, K. Azad, and Ibrahim, Y. Hakeem., (2013), Flexural behaviour of hybrid concrete beams reinforced with ultra-high performance concrete bars, Construction and Building Materials, Vol.49, pp.128-133.
3. Aleksandrs Korjakins, Patricija Kara and Nikolajs Toropovs., (2013), Improving quality of high-performance concrete by cavitation treatment of the raw materials, Procedia Engineering, Vol.57, pp.597-604.
4. Bai, Y., Darcy, F., and Basheer, P.A.M., (2005), Strength and drying shrinkage properties of concrete containing furnace bottom ash as fine aggregate, Construction and Building Materials, Vol.19, pp.691-697.
5. Bharatkumar, B.H., Narayanan, R., Raghuprasad, B.K., and Ramachandramurthy, D.S., (2001), Mix proportioning of high-performance concrete, Cement and Concrete Composites, Vol.23, pp.71-80.
6. Dalila Benamara, Bouzidi Mezghiche and Mechrough Fatma Zohra., (2014), The deformability of a high performance concrete (HPC), Physics Procedia, Eights International conference on Material sciences, CSM-ISM5, Vol.55, pp.342-347.
7. Diana Bajare, Girts Bumanis and Liga Upeniece., (2013), Coal combustion bottom ash as microfiller with pozzolanic properties for traditional concrete, Procedia Engineering, Vol.57, pp.149-158.
8. Eehab Ahmed Badrelding Khalil., and Mohamed Anwar., (2014), Carbonation of ternary cementitious concrete systems containing fly ash and silica fume, Water science Journal, Vol. 29, Issue 01, pp.36-44.
9. Elahi, A., Basheer, A.M., Nanukuttan, S.V., and Khan, Q.U.Z., (2010), Mechanical and Durability properties of High performance concretes containing supplementary cementitious materials, Construction and Building Materials, Vol.24, No.3, pp.292- 299.

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10. Fereshteh Alsadat Sabet, Nicolas Ali Libre and Mohammad Shekarchi., (2013), Mechanical and durability properties of self consolidating high performance concrete incorporating natural zeolite, silica fume and fly ash, Construction and Building Materials, Vol.44, pp.175-184.
11. Jieying Zhang, Daniel Cusson, Paulo Monteiro and John Harvey., (2008), New perspectives on maturity method and approach for high performance concrete applications, Cement and Concrete Research, Vol.38, pp.1438-1446.
12. Kadam, M.P., and Patil, Y.D., (2013), Effect of coal bottom ash as sand replacement on the properties of concrete with different w/c ratio, International Journal of Advanced Technology in Civil Engineering, Vol.02, Issue 01, pp.45- 50.
13. Karthikeyan Jayakumar, Akhil Upadhyay and Navrathan M. Bhandari., (2013), Creep and shrinkage behaviour of HPC, The Indian Concrete Journal, Vol.02, Issue. 03, pp.39-45.
14. Magda I Mousa., (2015), Effect of elevated temperature on the properties of silica fume and recycled rubber-filled high strength concretes, HBRC Journal, Vol.03, pp.1-7.
15. Magda, I. Mousa, (2015), Flexural behaviour and ductility of high strength concrete beams with tension lap slice, Alexandria Engineering Journal, Vol.54, pp.551-563.
16. Mageswari, M., and Vidivelli, B., (2010), The Use of sheet glass powder as Fine aggregate replacement in concrete, The Open Civil Engineering Journal, Vol.04, pp.65-71.
17. Magudeaswarnan, P., and Eswaramoorthi, P., (2013), Experimental study on Durability characteristics of High performance concrete, International Journal of Emerging Technology and Advanced Engineering, Vol.03, No.03, pp.507-510.
18. Mathiraja, C., (2013), Mechanical properties of concrete using bottom ash manufacturing sand and metallic fibres, International Journal of Innovations in Engineering and Technology, Vol.03, No.02, pp.245-248.
19. Mohd Zain, M.F., Lai, F.C., Wang, B.M., and Mahmud, H.B., (2003), HPC: High early strength & ultimate strength, high durability by using silica fume, slag, fly ash and superplasticizer for hot tropical countries, Proceedings of 7th International conference on ACS, China, pp. 931-938.
20. Muhammad Fauzi Mohd. Zain, Nazrul Islam Md., and Hassan Basri Ir., (2005), An expert system for mix design of high performance concrete, Advances in Engineering Structures, Vol.36, pp.325-337.
21. Ozgur Cakir., and Omer Ozkan Sofyanli., (2015), Influence of silica fume on mechanical and physical properties of recycled aggregate concrete, HBRC Journal, Vol.11, pp.157- 166.
22. Prabhat, R. Prem., Ramachandra Murthy, A., Ramesh G., Bharatmkumar, B.H., and Nagesh, R. Iyer., (2015), Flexural behavior of damaged RC beams strengthened with ultra high performance concrete, The Indian Concrete Journal, Vol.89, No.01, pp.60-68.
23. Purushothaman, M., and Senthamarai, Rm., (2012), High performance concrete using bottom ash as fine aggregate, Journal of Structural Engineering, Vol.39, No.1, pp.56-60.
24. Purushothaman, M., and Senthamarai, Rm., (2013), Strength properties of High performance concrete using bottom ash as fine aggregate, International Journal of Civil Engineering, Vol.02, No.03, pp.35-40.
25. Saaid, I. Zaki, Ibrahim, M. Metwally, and Sameh, A. El-Betar., (2011), Flexural Behaviour of reinforced high performance concrete beams made with steel slag coarse aggregate, ISRN Civil Engineering, Vol.10, pp.38-48.
26. Venkatesh Babu, D.L., Natesan, S.C. and Selvarani, M., (2004), Establishment of Empirical Relationship between process parameters and some properties of high performance concrete silica fume concrete, Proceedings of International conference on Advance in concrete and construction, pp.755-764.
27. Wang Zongling, Li Guodong., (2013), Experimental method and prediction model for autogenous shrinkage of high performance concrete, Construction and Building Materials, Vo.49, pp.400-406.
28. Wasan, I. Khalil and Tayfur, Y.R., (2013), Flexural strength of fibrous ultra high performance reinforced concrete beams, ARPN Journal of Engineering and Applied Sciences, Vol.08, No.03, pp. 200-214.
29. Yang, I.H, Changbin Joh and Byung-Suk Kim., (2010), Structural behaviour of ultra high performance concrete beams subjected to bending, Engineering structure, Vol.03, pp.3478-3487.
30. Yogesh Aggarwal, and Rafat Siddique., (2014), Microstructure and properties of concrete using bottom ash and waste foundry sand as partial replacement of fine aggregates, Construction and Building Materials, Vol.54, pp.210-223.
31. Yoo, S.W., Kwon, S.J., and Jung, S.H., (2012), Analysis Technique for Autogenous shrinkage in High performance concrete with Mineral and chemical admixtures, Construction and Building materials, Vol.34, pp.1-10.
32. Yang, I.H., Joh, C., and Kim, B.S., (2011), Flexural strength of ultra-high strength concrete beams reinforced with steel fibers, Procedia Engineering, Vol.14, pp.793-796.
33. Zain, M.F.M., Suhad, M. Abd, Sopian, K., Jamil, M., and Che-Ani, A.I., (2012), Mathematical Regression model for the prediction of concrete strength, Mathematical methods, computational techniques, non-linear systems, intelligent systems, Vol.03, pp.396-402.