International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Self Curing Concrete with a Partial Replacement of Cement by Steel Slag

[1]G Raghu, [2]P Raman, [3]T Sakthivel*

[1,2,3]Lecturer, Department of Civil Engineering, SRMV Polytechnic College, Coimbatore - 641 020, India

A B S T R A C T

Today concrete is most widely used construction material due to its good compressive strength and durability. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days with water binder ratio of 0.50 for good hydration and to attain desired strength. The curing will badly affect the strength and durability of concrete. **SELF CURING CONCRETE** is one the special concretes in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. The present study involves the use of shrinkage reducing admixture polyethylene glycol (PEG-600) in concrete which helps in self curing and helps in better hydration and hence strength. In the present study, the affect of the admixture (PEG – 600) on compressive strength by varying the percentage of PEG by weight of water from 0%, 0.25%, 0.5, 1%, 1.5%, 2% were and it is also study by varying the percentage of STEEL SLAG by weight of cement from 0%, 5%, 10%, 15%, 20%, 25% were studied $\mathbf{M_{20}}$ mix. It was found that PEG - 600 could help in self curing by giving strength on par with conventional curing. It was found that 1.5%of PEG - 600 for weight of water was optimum moisture content for M_{20} grade concrete with and without steel slag for achieving maximum strength without compromising workability. It is also found that by replacing up to 20% of cement with steel slag shows increase in strength of concrete and shows slight reduction in strength for 25% replacement.

Keywords: Cement, fine aggregate, coarse aggregate, polyethylene glycol (PEG-600), STEEL SLAG

1. Introduction

Self-Curing is a technique which is used to retain proper moisture contents in concrete for better hydration for a long time. Self-Curing agent works to reduce self desiccation contents present in the concrete. So some of shrinkage reducing agents are used to avoid and the concrete cures itself.

Steel slag is an industrial by product from the steel manufacturing industry. This can be used as cement in concrete. Steel slag is the residue of steel making industry; the emission amount is about 12 to 20 percent of rough steel production. However, steel slag has not been used efficiently and thoroughly for long, which causes its great accumulation, waste of land, and serious air and water pollution. Steel slag has certain amount of important minerals of cement clinker, such as C2S and C3S.So it can be used as cement and concrete admixtures.

India’s steel output ranks No2 in the world, but the comprehensive utilization rate of steel slag and slag is only 10 percent at present. With Iron and steel production amounting to 8 million tons in 2009, is an important iron and steel base of India. If the steel slag occupies 15 percent of steel production (quality percentage) then the emission amount is 1.2 million tons. So, if cement can be replaced by steel slag and not only can the activity of slag be fully simulated but also the durability of concrete can be improved.

Nomenclature

PEG 600- Polyethylene glycol 600

SS - Steel slag

SSC -Steel slag concrete

SCC - Self curing concrete

SAP - Super absorbent polymer

2. Literature review

2.1 Self Curing Concrete

Concrete now serves as a backbone of the infrastructural development of every country. We have a long way to go to learn and practice the art and science of making quality concrete. The past studies on adding of PEG 400 with water were studied by conducting literature survey and some of them are listed below.

2.1.1 Strength characteristics of self-curing concrete. M.v.jagannadha kumar, IJRT, SEP 2012 VOLUME: 1 ,ISSUE: 1 ISSN: 2319-1163

The optimum dosage of PEG400 for maximum strengths (compressive, tensile and modulus of rupture) was found to be 1% for M20 and 0.5% for M40 grades of concrete. The compaction factor increases with increase in dosage of PEG 400. It also states that self-curing concrete is the only answer for many problems caused in curing.

2.1.2 Preliminary Studies of Self Curing Concrete with the Addition of polyethylene Glycol. Sathanandham. T,Gobinath.R, Naveenprabhu.M, Gnanasundar. S, Vajravel. K, Sabariraja. G, Manoj Kumar. R, Jagathishprabu. VOL. 2, ISSUE 11, ISSN: 2278-0181, (NOV2013)

The optimum dosage of PEG4000 for maximum Compressive strength was found to be 1.5% for grades of concrete. As percentage of PEG4000 increased slump increased for M20 grade of concrete. Strength of self-curing concrete is on par with conventional concrete. Self-curing concrete is the answer to many problems faced due to lack of proper curing. Wrapped curing is less efficient than Membrane curing and Self-Curing it can be applied to simple as well as complex shapes.

2.1.3 Experimental investigation on mechanical properties of self curing concrete. Amal francis k,jino john Vol 2, Issue 3,ISSN 2249-6149, (March 2013).

Addition of SAP leads to a significant increase of mechanical strength. Maximum compressive stress developed in M-40 grade self-curing concrete by adding sap 0.3% of cement. Performance of the self-curing agent will be affected by the mix proportion mainly the cement content and the w/c ratio.

2.1.4 The mechanical properties of solidified polyethylene glycol 600, an analog for lava crust s.a. Soule, k.v. Cashman.

Experiments on solidified PEG 600 reveal temperature-dependent mechanical properties that are best described by power law models. A transition between ductile and brittle behavior of PEG 600at a dimensionless temperature of 0.5 and strain rate of 0.05 is evidenced by a change in the dominant fracture style from type I to III and a step-like increase in Young's modulus (E) that yields a relaxation time of 500. The relaxation time is an inverse function of temperature.

2.2. Steel Slag

Concrete now serves as a back bone of the infrastructural developments of every country. We have a long way to go to learn and practice the art and science of making quality concrete. The past studies on various types of slag replacements were studied by conducting literature survey and some of them are listed below.

2.2.1. Properties and hydration of blended cements with steelmaking slag. S. Kourounis, s. Tsivilis, p.e. Tsakiridis, g.d. Papadimitriou, z. Tsibouki cement and concrete research , ISSN 815–822, (2007).

The present research study investigates the properties and hydration of blended cements with steelmaking slag, a by-product of the conversion process of iron to steel. For this purpose, a reference sample and three cements containing up to 45% w/w steel slag were tested. The steel slag fraction used was the "0-5 mm", due to its high content in calcium silicate phases. Initial and final setting time, standard consistency, flow of normal mortar, autoclave expansion and compressive strength at 2, 7, 28 and 90 days were measured. The hydrated products were identified by X-ray diffraction while the non-evaporable water was determined by TGA. The microstructure of the hardened cement pastes and their morphological characteristics were examined by scanning electron microscopy. It is concluded that slag can be used in the production of composite cements of the strength classes42.5 and 32.5 of EN 197-1. In addition, the slag cements present satisfactory physical properties. The steel slag slows down the hydration of the blended cements, due to the morphology of contained C2S and its low content in calcium silicates.

2.2.2. Physical properties of steel slag to be reused in a landfill cover. L.andreas, i.herrmann, m.lidstrom-larsson and a.lagerkvist.

Many landfills in Sweden as well as in Europe have to be closed in the near future. Apart from materials costs in the order of tens of billions Euro, this puts a strain on the environment through the exploitation of virgin materials. Many landfills operators are considering alternative cover constructions including slags from a steel mill. Four electric arc furnace (EAF) slags and one ladle slag from Uddeholm Tooling AB at Hagfors, about 270 km Northwest of Stockholm, were investigated with regard to their physical properties. A full scale field test on an area of about 5,000 m2 will be started at the municipal landfill in Hagfors in August 2005.

2.2.3. Using of steel slag inmodification of concrete properties.dr. Khidhair j.mohammed, dr.falak o.abbasand mohammed o.abbas.

Steel slag which can be considered as solid waste pollutant was used in concrete mixture for road bases and surfaces, bridges, asphaltic concrete, clinker raw material and other fields, instead of cement or filling material. In this work, steel slag was used as replacement of aggregate or stone, which has the highest content in concrete mixture. Four groups of concrete mixtures with (0, 25, 50and 60%) by wt. of steel slag from Basrah steel plant were used instead of aggregate. The first group, without slag, as a standard mixture was used to compare its properties with those of (25, 50 and 60%) by wt. steel slag. The obtained results showed that, density of concrete and compressive strength, also flexural force, after 7 days and28 days were increased by increasing slag content, while water absorbed content was decreased by increasing slag content. Those results insure the importance of using steel slag not only in modification of concrete properties, but also to save the environment from huge quantities of slag as solid waste.

2.2.4. Broader use of steel slag aggregates in concrete. Jigar p. Patel.

Hence concluded that durability of steel slag aggregates concrete under freeze thaw environment was the main goal in this research, as there was a belief that the steel slag aggregates have expensive characteristics and would cause cracking in concrete. The results provide that if up to 50 to 75% of steel slag aggregates are incorporated in traditional concrete, there would not be much change in the durability of concrete.

2.2.5. Experimental investigation on paver blocks usingsteel slagas partial replacement of aggregate andsludge as partial replacement of cement. Jayakumar. p, ram kumar .v, suresh babu .r, mahesh kumar .m international journal of science and research (IJSR), India Online ISSN: 2319-7064.

The scarcity of raw materials required for construction is increasing day by day due to globalization. The metallurgical steel slag from industries creates great concern to the environment. These steel slags may be used as substitution of natural aggregate in the field of construction. The magnitude of the sludge derived from the chemical processing of textile industry is larger than other industries. Since the pollutants in the sludge lead to problems of ground water pollution, extreme change in soil condition, adverse effects on plants and poor productivity of soil. It is necessary to develop a suitable technology for conversion of the textile sludge and slag into Eco-friendly and useful construction materials. In this study, it is proposed to utilize the textile sludge as partial replacement of cement and steel slag as partial replacement of coarse aggregate in the production of sludge based paver blocks. Paver blocks were cast with sludge as cement replacement material at 0, 10, 20, 30 and 40 percent and Steel slag at 0, 10, 20, 30 and 40 percent as coarse aggregate replacement for the above combinations. Tests for compressive strength at 7 days were conducted. Compressive strength on 28days, flexural strength, and rapid chloride permeability test (RCPT) and water absorption at 28 days are to be conducted on the paver blocks. It is proposed to carry out the cost analysis for the paver block mix combinations (sludge and steel slag) with commercial paver blocks.

3. Conclusion

In this paper we collected the literature to self curing concrete with partial replacement of steel slag. Self-curing concrete is the answer to many problems faced due to lack of proper curing. The optimum dosage of PEG400 for maximum strengths (compressive, tensile and modulus of rupture) was found to be 1% for M20 and 0.5% for M40 grades of concrete. The compaction factor increases with increase in dosage of PEG 400. It also states that self-curing concrete is the only answer for many problems caused in curing.

Slag can be used in the production of composite cements of the strength and the slag cements present satisfactory physical properties. The steel slag slows down the hydration of the blended cements, due to the morphology of contained C_2S and its low content in calcium silicates

Steel slag was used as replacement of aggregate or stone, which has the highest content in concrete mixture. Four groups of concrete mixtures with (0, 25, 50 and 60%) by wt. of steel slag from steel plant were used instead of aggregate. provide that if up to 50 to 75% of steel slag aggregates are incorporated in traditional concrete, there would not be much change in the durability of concrete.

4. Scope of future study

Based on the study carried out on mechanical properties of self-curing concrete mix with steel slag as a partial replacement of cement at various percentage replacements of cement and the optimum dosage of PEG 600 of maximum compressive strength is to find for M_{20} grades of concrete with steel slag and without steel slag and also finding the Strength properties of self-curing concrete and compare with conventional concrete.

References

1. Dale P. Bentz, max A.peltz, Kenneth A.Synder and Jeffery M.Davis , verdict : viscosity enhancers reducing diffusion in concrete technology, concrete international, January 2009.
2. A. Aielstein Rozario, Dr.C.Freeda Christy, M.HannahAngelin, experimental studies on effects of sulphate resistance on self-curing concrete, Vol. 2 Issue 4, April – 2013, ISSN: 2278-0181
3. Tarun R. Naik and Fethullah Canpolat, self-curing concrete, April 2006
4. Self-curing concrete using water soluble polymers, UAEU
5. M. S.Ravikumar, Selvamony.C,S.U.kannan, S.basilgnanappa, Behaviour of self-compacted self-curing kiln ash concrete with various admixtures, VOL. 4, NO. 8, OCTOBER 2009, ISSN 1819-6608
6. Hajime Okamura and Masahiro Ouchi, self-compacting to achieve durable concrete structures, Journals of Advanced Concrete Technology,Vol.1, No.1, April 2003.

7. H.J.H. Brouwers and H.J. Radix, Theoretical and experimental study of Self-Compacting Concrete, Cement and Concrete Research, 9 june 2005, pp 2116-2136.

8. Mustafa Sahmaran and I. OzgurYaman, Hybrid steel slag reinforced self-compacting. Concrete with a high-volume coarse fly ash, Elseevier science publisher.30 June 2005, (PP 109-126).

9. Gutt w, Kinniburg w, Newman AJ,(1967) “Blast Furnace Slag as a aggregate for concrete” Magazine of concrete Research Vol 19, PP 59.