A Study on Stainless Steel in Concrete for its Various Usages

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ABSTRACT

Stainless steel is a form of steel which is normally used in architectural works. At present many researches are taken in using the material Stainless steel and its byproducts in concrete. Some of them are usage of Stainless steel slag as partial replacement in concrete, as strands in prestressed concrete and reinforcement bar in concrete. Few research journals are also published in these fields. Therefore to use the material stainless steel in the concrete, few suggestions made by the researchers are to be studied. In this idea this paper presents the abstract of the few researches made in usage of stainless steel in concrete.

Keywords--- Stainless Steel Slags, Stainless Steel Slags, Stainless Steel bars.

I. INTRODUCTION

In the last few decades there has been rapid increase in the waste materials and by-products. Some of the industrial by-products like GGBS, fly ash, Stainless steel slag, copper slag, silica fume have been successfully replaced for cement and concrete in the construction industry. It reduces the consumption of natural resources. Stainless steel slag is one of the materials that is considered as a by-product (waste material) obtained during the matte smelting and refining of steel. It has the physical properties similar to the fine aggregate, so it can be used as a replacement for fine aggregate in concrete.

In the other form, stainless steel as reinforcement in concrete and as pre stressing strands in prestressed concrete are the new area of research. This paper deals with the review of various literatures in which the usage of stainless slag as a replacement of aggregate in the concrete and few other forms like stainless steel as reinforcement bar and prestresses strand.

II. SELF-COMPACTING CONCRETE

Yeong-nain Sheena, Li-Jeng Huanga, Te-Ho Suna and Duc-Hien Leb made research in the modification of engineering properties of the self compacting concrete. According to their journal “Engineering Properties of Self-compacting Concrete Containing Stainless Steel Slags” published in Journal of Sustainable Development of Civil, Urban and Transportation Engineering Procedia Engineering 142 (2016) 79 – 86. They substituted the stainless steel slag as a replacement of natural aggregates in a proportion of 0%, 50%, and 100%, this replaces the percentage of Portland cement (0%, 10%, 20%, and 30%) with maintaining a water cement binder of w/b = 0.4. Hardened properties like compressive strength, surface resistivity and ultrasonic pulse velocity were examined experimentally.

They founded that results with 100 % stainless steel oxidizing slag (SSOS) substitutes to aggregates and 30 % stainless steel reducing slag (SSRS) substitutes of Portland cement in Self Compacting Concrete, the compressive strength increases electrical resistivity and the 91 day ultrasonic pulse velocity are within the good quality concrete requirement. By this 43 % of cost of SCC with this substitution gets reduced. This can be treated as environmental friendly, since the usage of waste to make concrete with increase in strength. They have also suggested that replacement ratio of 10% SSRS could provide, the highest sulfate resistivity, evaluated by weight-loss test. The same research was published in few journals such as Journal of Materials & Design Volume 96, 15 April 2016, Pages 16-26 and Journal of construction and Building Materials Volume 82, 1 May 2015, Pages 341–350.

III. STAINLESS STEEL WIRES IN CONCRETE
Short-cut super-fine stainless wire (SSSW) with super-fine diameter and high aspect ratio is used to reinforce reactive powder concrete (RPC) by the researchers Baoguo Han, Sufen Dong, Jinping Ou, Chenyu Zhang, Yanlei Wang, Xun Yud, Siqi Ding. In their publication made in Journal of Materials engineering April 2009, Pages 48–52, they have reviewed the mechanical behavior of SSSW and RPC matrix. They have suggested that usage of stainless steel wires in concrete increases the flexural strength by 103% and fracture energy by 442%. The Bond strength between wire and matrix was incorporated into composite theory to establish flexural strength model of concrete. They concluded that Model considering effective coefficient of wire numbers is satisfactory for describing flexural toughness of wire/concrete. A graphical abstract of their research is as follows:

IV. STAINLESS STEEL REINFORCING BAR

Corrosion of carbon steel reinforcing bar can lead to deterioration of concrete structures, especially in regions where road salt is heavily used or in areas close to sea water. Although stainless steel reinforcing bar costs more than carbon steel, its selective use for high risk elements is cost-effective when the whole life costs of the structure are taken into account. Considerations for specifying stainless steel reinforcing bars and a review of applications was made by L. Gardner, Y. Bu, P. Francis, N.R. Baddoo and K.A. Cashell. In their journal published in Cement and Concrete Composites Volume 72, September 2016, Pages 48–65 they used bars of 12mm and 16mm as reinforcement. They made isothermal and anisothermal tensile tests in those bars. The test results demonstrate that the reduction factors for 0.2% proof strength, strength at 2% strain and ultimate strength derived for stainless steel plate and strip can also be applied to stainless steel reinforcing bar. Revised reduction factors for ultimate strain and fracture strain at elevated temperatures have been proposed for further research.

Similar type of research was conducted by R.G. Duarte, A.S. Castela, R. Neves, L. Freire and M.F. Montemor for Corrosion Behavior of Stainless Steel Rebars Embedded in Concrete. Electrochemical Impedance Spectroscopy (EIS) was used for studying the electrochemical behavior.

Concrete specimens were exposed to chloride containing solutions simulating the aggressive conditions found in sweater environments. Samples were fully immersed and submitted to periodic immersion/emersion cycles. EIS and open circuit potential (OCP) were monitored in a monthly basis. Samples containing carbon steel (C-steel) rebars were also prepared for comparison of the corrosion rates between the different materials. The results showed that the austenitic and duplex SAF 2205 stainless steels were passive for all the testing period, due to the formation of protective oxide layer, with the AISI 316 presenting the higher corrosion resistance value. The EIS results suggest an increase of more than one order of magnitude in the corrosion resistance of the duplex steels and AISI 316 comparatively to C-steel rebars.

V. ADVANTAGES OF USING STAINLESS STEEL

Self compacting concrete-
1. Cost of production of is reduced by 43% by using the stainless steel slag as replacement
2. Replacement ratio of 10% stainless steel reducing slag (SSRS) could provide, the highest sulfate resistivity.

Reinforcement Bars-
1. Corrosion is less when compared with the normal steel bars.
2. Ultimate strength increases by 2% if the stainless steel bars are treated in thermal environment.

Wires in prestressed concrete-
1. Flexural strength increases by 103% and fracture energy by 442%.
2. Bond strength increases if the surface is ribbed.

VI. CONCLUSION

Present day research shows that the usage of stainless steel in concrete increases the strength and corrosion resistance. Since the stainless steel bars have to undergo thermal treatment, the cost will increase. But the cost will not be as much as that for the treatment of concrete with it is affected by corrosion. While stainless steel wires if used as strands in prestress concrete, the tensile strength increases.

Therefore the usage of stainless steel in the form of replacement, rebars, wires in concrete has advantage over nominal steel in terms of strength and corrosion resistance.
REFERENCE


