International Journal of Emerging Trends in Engineering and Basic Sciences (IJEEBS)
ISSN (Online) 2349-6967
Volume 7, Special Issue 2 (March-April 2020), PP. 169-173

To Study the Compressive Strength of Concrete by using Industrial Waste (WFS): A Review

Akanksha P. Tawade[1], Sapana A. Thengare[1], Prachi V. Dhopate[1], Pratiksha D. Tidke[1], Kajal N. Meshram[1], Komal S. Khobragde[1], Aasif M. Baig[2]

[1]*Department of Civil Engineering, Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur, India*

[2] *Department of Civil Engineering, Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur, India*

Abstract: The use of waste materials in the building industry is a major challenge for the efficient construction. In Brazil more than 3 million tonnes of waste foundry sand are generated annually. The industry that provided WFS for this work generates about 1240 tonnes of this waste in every month alone, Concrete is used in construction material. WFS is one of the promising material which needs to be studied extensively as a substitute of fine aggregate in the concrete. WFS is a By-product of ferrous and non-ferrous metal casting industries and it contains high quality silica sand for their moulding and casting process. This WFS is black in colour and it contains large amount of fines. The physical property and chemical property of waste foundry sand (WFS) is dependent upon type of furnace and type of finishing process. Natural or river sand (fine aggregate) was replace with 0%, 5%, 10%, 15% and 20% of waste foundry sand by mass. Usually raw sand is a higher quality than typical natural sand used in the fill construction sites therefore it can be a very competent material for sand replacement.

Keywords: Industrial Waste, Waste Foundry Sand, Fine Aggregate, Concrete, Compressive Strength.

I. Introduction

The use of waste materials in building or construction industry is a major challenge for efficient construction. In Brazil approximately generates more than 3 million tonnes of WFS annually, and it making one of the largest industrial wastes produced in the country. Brazil is seventh ranked in the work which cast iron production with annual production of 3 million tonnes of WFS .foundry industries produced larger amount of by -product material during casting process . In foundry the ferrous metal casts are steel and cast iron and non-ferrous metal casts are brass , copper , aluminium, and bronze. Foundry industries use high silica sand for their moulding and casting process. Foundry recycles and re-uses sand in many times in foundry but when it cannot longer be reused in foundry then it is removed from the industry. The removing sand is knows as waste foundry sand, it is black in colour and it contents large amount of fine particles. The use of waste products from the foundry industry in concrete is not only makes it economical, but also it help in reducing environmental degradation and disposal problems. The waste materials required for the replacement of fine aggregate are processed to required specification that could match with properties of fine aggregate to be used in the concrete. Such type of industrial wastes of by-product of namely WFS was treated and it use as a partial replacement material for the fine aggregate in the concrete. Natural Sand (Fine aggregate) was replaced with 0% ,5%, 10%, 15%, and 20% of WFS by the mass.Metal alloy casting industry only produces several million tonnes of by-product in the world and WFS is a major by-product. It has being use for land filling material since many years but due to the rising disposal cost and land filling a also become a problem. In united States has about 3 thousands foundry which is annually utilised 100 million tonnes of and for this production and about 6- 10 million metric tonnes of WFS is discarded per years which goes into the landfill. The use of high quality silica Sand for uses in their moulding and casting operation usually wrong sand is higher quality than natural Sand which used in fill construction site therefore it can be a very competent material for the sand replacement.

II. Literature Review

Chong- Lyuck Park, Byoung- Gon Kim, YoungChul Yu:-It is observed that, each casting 30-60% waste foundry sand produced. In this study, waste foundry sand used for casting process. The percentage of Si_2O_2 in foundry sand or green sand was 94%, The range of Si_2O_2 in waste foundry sand was 87% to 90%. The main impurities of WFS Fe_2O_3 and Na_2O_3.

Maria Auxiliadora de Barros Martins, Regina Mambeli Barros, Gilbert Silva, Ivan Felipe Silva dos Santos:- During study they replaced natural sand with foundry sand 0 to 50% at the increment of 10% by weight in conventional concrete. Some authors said that this study carried out to avoid the environmental pollution by the reused of waste foundry exhausted sand to find compressive strength. They were casted 100mmx200mm cylinder for each mix proportion and after casting they were proceed for curing process and then 7 and 28 day they were tested cylinder. In this study he said that CVP HIR- high initial resistance cement was used with the Brazillian Association of Portland cement (BAPC) mixture design method. As per Brazillian standard NBR 10005 and NBR 10006 they were carried out the chemical analysis and leachate and stabilized proceedings results.

Paulo Ricardo de Matos, Matheus Felipe Maron, RudielaAparecidaSchankoski, Luiz Roberto Prudencio:-They were observed that the high percentage of silica were presents in foundry sand and it is used in the ferrous and non-ferrous metal casting industries. The 100kg of waste foundry sand they were collected from Joinville, SC, Brazil metal casting industry and the density of this sample was, 2.54g/cm^3, and fineness modulus was 1.00 and loss of ignition at 900^{0}C of 3.52%. In this study lignosulphonate- based plasticizer (Mira sat 48. Grace) was used in concrete mix proportion. As per the manufacturer, the density of the plasticizer was 1.21g/cm^3, p^H of 8.0 and solid content of 32.8%, and for the dry-mix concrete mix proportion of an air-entraining admixture (Tech Foam, Grace) with density of 1.04g/cm^3 and p^H of 11.5 was used.

Bavita Bhardwaj, Pardeep Kumar:- In this study, the value of IRA was reduced and the value of waste foundry sand is increased upto the 60%. The lowest value of the mix proportion was GF60 that is 0.0188 mm/sec$^{1/2}$. In GPS mixes, the value of IRA reduced shown by mix proportion GF20, GF40 & GF60 respectively about 10%, 40%, 48% less than mix GF0. It is analysed that, addition of WFS in concrete decreased the fluidity of fresh concrete and increased with the cohesiveness. In addition of waste foundry sand in concrete increasing the water demand and reducing the slump of concrete.

RafatSiddhiqui, Yogesh aggrawal, PratibhaAggrawal, EI-HadiKadri, RachidBennacer:- It is state that compressive strength as well as split tensile strength was determined at 28, 90 and 365 days made up of rapid chloride penetration resistance and carbonation at 90 and 365 days. The substitute of fine aggregate with foundry sand put down as suitable 30% and should not have 50%.

Anthony Torres, Laura bartlett, Coleb pilgrim:- Compressive test were carried out to evaluate the strength properties of concrete at age of 7, 28, 91 day. Partial replacement of sand with WFS up to 15% increase the compressive strength of concrete. Compressive strength has strong relationship with RCPT and ultrasonic pulse velocity test rapid chloride permissibility test. Increase in compressive strength with inclusion of WFS in concrete leads to an increase in chloride ion penetrability and improve the quality of concrete in term of density homogeneity.

Maria Auxiliadora de Barros Martins, Regina Mambeli Baros, Gibert Silva, Iran Felipe Silva dos Santos:- With six different proportion in the conventional concrete fine aggregate was partially replaced with WFES (Waste Foundry Exhaust Sand) with 0%, 10%, 20%, 30%, 40% and 50% by the weight, in order the compressive strength of more than 25MPa obtained. Waste Foundry Sand (WFS) is composed of the base sand, generally high quality, bentonite clay used as binding material (4%-15%), low cost silica sand (85%-95%), carbonaceous additive (2%-10%) is improve water (2%-5%) and the surface finishing. The splitting tensile strength of samples with replacement of 10%, 20%, 30%, 40% and 50% of the fine aggregate by the waste foundry exhaust sand (WFES) was higher than control mixture, it resulting

6.3%, 2.3%, 4.7%, 13.5% and 10.5% increase. It may be observed that on the 30th day there was specific gravity of concrete increase of less than 1% with 40% of the fine aggregate in substituted by the WFES. The hardened concrete sampler present in the best result with 40% substitution of the fine aggregate by WFES. With a 40% of the fine aggregate substituted by Waste Foundry Exhaust Sand (WFES) which is lowest result was obtained and it shows that concrete become denser. On 28th days the compressive strength increased of 8.25%, 17% with replacement 35 to 20% of fine aggregate by WFS.

G. Ganesh Prabhu, Jung Hwan Hyun, Yun Yong Kim:- The compressive strength of concrete is directly depend on time.FCM=Fc28 (t/4+0.85t) Where, FCM=mean compressive strength at t days.Fc28=28 days. It is concluded that FS can be used for good concrete up to 20%.it does not affect concrete standard. It concluded that 20% of FS is replaced with fine aggregate. It gives 1.6% strength and 30% gives the 5.7% of compressive strength. 20% substitution is established as an optimum proportion of FS in concrete making.

Gurpreetsingh, Rafat Siddique:- The test result indicate that replacement of sand with WFS enhanced the 28 day compressive strength by 8.3-1% splitting tensile strength by 3.6-10.4% and modulus of elasticity by 1.7-6.4% depending upon the WFS content and showed continuous improvement in mechanical properties up to the ages of 365 days.The ferrous metal cast in foundry are cast iron and steel and non-ferrous metal are aluminium copper brass and bronz. In that properties find out compressive indicated test result the replacement of sand with WFS to extend of 28 days compressive strength by 8.3-7%.

Yogesh aggarwal, rafatsiddiqui:- The use of waste from the foundry industry and bottom ash from electrostatic precipitators as recycling in fine aggregate in the production of concrete for structural purpose.The mix FB 60 is not recommended as the water content of this mix is high with also reflect on various strength. The made form foundry industry and bottom ash is fine aggregate is maximum replacement could be taken as 50%. The hydration process was not observed to change in the concrete. The substituting material fine aggregate with industrial by product aggregate is economic and environmental. The great importance in present content of suitability in the construction rotor.

Lakshmi N. Reddi, George P. Rieck, A.P. Schwab, S.T. Chou, L. T. Fan:- In this paper the results suggest that compressive strength was acquired relatively faster in fly ash than in cement and in general, it varied inversely with the proportion of foundry sand in the stabilized mix.

An Deng, Paul J. Tikalsky:- The laboratory studies include the the physical, geotechnical and leaching properties of the flowable fills consisting of the WFS, cement and fly ash mixed to different water contents.The main properties measured includes WFS physical properties (density, particles gradation , grain shape, and fine content), WFS flowable fill geotechnical properties (unconfined compressive strength, hydraulic conductivity, setting time, and bleeding), and the fills leaching properties (heavy metals and organics in the bleed water and the leachate extracted from hardened WFS flowable fill).

III. Conclusion

(i) At the level of 50% replacement of WFS as a natural sand beneficial for concrete. for initial stage of concrete the shrinkage rate increase day by day up to 28 days.

(ii) It is concluded that WFS is non-hazardous waste and having better durability.

(iii) Up to 20% weight of natural sand which collected from river replacement of WFS gives higher compressive strength, splitting tensile test ,flexural strength.

(iv) The test results show that WFS is very wind for making a good quality of mortar.

(v) The test result shows that the replacement of WFS with natural sand use full to microstructure, economical to green concrete.

(vi) Also for making of bricks the WFS is used as a raw material.

(vii) The benefits of replacement of WFS to save the natural resources.

(viii) Abrasion test increases as WFS increases in concrete with which is correlated with compressive strength, splitting tensile strength, flexural strength.

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