A Study on Mechanical Properties of Concrete Replacing Fine Aggregate with Steel Scrap

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Abstract

Now a day without concrete we can't imagine the world so in such conditions as a civil engineer it is the ultimate job to get the maximum output at reasonable input without causing any effect to the nature nothing but environment. High density concrete was mainly used in the construction of nuclear power plants, rail sleepers, counter wait for lifting cranes and in many other structures also. The main aim of this paper deals with the high density concrete that means to get the maximum density by using the locally available material steel scrap (mild steel bars dross) as a replacement of fine aggregate in different proportions of 50% and 100% with the considerable water cement ratio. This may result the change in physical and chemical properties like density, compressive strength, tensile strength, freeze-thaw resistance and apart from all these the main foremost thing is it should resist the thermal property also. Here the fine aggregate replacement by steel dross is economical because this steel dross is locally available material we can get this from the metal cutting workshops that is maximum there is no use of this regarding any activity in any area. By doing the sieve analysis for the steel dross it came under zone II as here the replacement is of fine aggregate(FA) is also the same zone so it an advantage to obtain the optimum results.

Keywords: High density concrete, mild steel dust, fine aggregate, physical and chemical properties

I. INTRODUCTION

Now a day's concrete especially the conventional concrete is using worldwide in the construction industry mainly with the ingredients as water, cement, traditional silica-calcareous aggregates (sand and gravel) and chemical admixtures (super plasticizers, air entrainers, set retarders etc,).and many experiments are going on the concrete to replace the ingredients like coarse aggregates, fine aggregates and cement and there is a possibility of replacing the fine aggregate with iron dust is useful for the development of high density concrete.

It not only saves the environment and land fill space but also the extraction of natural raw materials (sand). Preserving the natural raw materials i.e., fine aggregate is a matter of sustainable development that to ensure the sufficient resources for the future generations. Present days with increasing of pressure on the environmental aspect to reduce the pollution impact on the environment should go for the reusing of materials in as many as possible ways i.e., plastics, metals, glass are the most common materials.

II. LITERATURE REVIEW

Janis Kazjonovs, Diana Bajare, Aleksandrs Korjakins(2010)at riga technical university, study regarding the high density concrete with replacement of coarse aggregate and fine aggregate with steel dross and steel punchings respectively.

The steel dross and steel punching (steel treatment waste products) can be use as aggregates in production of high density concrete. By this it was feasible to design a concrete of density up to 4640 kg/m3. And there is much variation in the density compared to conventional i.e., for 50 and 100 % replacement of aggregates in the concrete it result in 1.47 and 1.93 times respectively.

Jeet Digant Kapadia, Sourabh Surendra Manjrekar at Installation of Cyclotron radiation therapy unit at Tata Cancer Radiation Center, Mumbai in the basement. Study regarding the installment of the basement in the hardened state, it forms a non shrink material and hence crack-free which is very important for radiation proof concrete.

It has good bond strength, is compact and very dense and hence the formation of honeycombs is almost next to impossible. This makes it an excellent choice for applications like radiation proof concrete as the formation of honeycombs would render the walls susceptible to leakage of radiation.

III. EXPERIMENTAL ANALYSIS

A. Materials:

Detailed information about the materials used and their characteristics are given in this section.
Portland cement has been found to be adequate for production of high density concrete.

Experience has indicated that Portland cement is economical in most cases, entirely satisfactory and adequate for construction. Chemical composition of cement is shown in table 1. Aggregates used are coarse aggregates and fine aggregates having specific gravity 2.7 found from standard tests. Coarse aggregate of size 12.5 mm and fine aggregate of Zone 2 passing through 4.75 mm sieve is used. Iron dross was used in this programme as admixture. Iron dross is a steel treatment waste which is produced in metal cutting workshops. A sample of iron dross is shown in Fig 1. The mineralogical content of iron dross was determined by X-ray analyze. Iron dross contains FeO, α-Fe2O3 and MgO·40CuO·10ZnO·50Fe2O4 and it has specific gravity 2.8 taken from reference .Iron dross passing through 4.75 mm sieve is used and founded it Zone by sieve analysis and it came under Zone 2 shown in fig 2. To reduce the w/c ratios galinium is added as a chemical admixture (super plasticizer). SP galinium is supplied as a liquid instantly dispersible in water.

Fig. 1:

Table - 1
Sieve Analysis for 500 Gms Of Steel Dross

Sieve size in mm	*WTRETAINED IN gms*	*CUMULATIVE WT RETAINED Gms*	*CUMULATIVE% retained*	*cumulative% passing*
10	*0*	*0*	*0*	*100*
4.75	*0*	*0*	*0*	*100*
2.36	*4*	*4*	*0.8*	*99.8*
1.18	*141*	*145*	*2.9*	*71*
0.6	*321.5*	*466.5*	*93.3*	*6.7*
0.3	*25.5*	*492*	*98.4*	*1.6*
0.15	*0*	*0*	*0*	*0*
0.15	*8*	*500*	*319.4*	*0*

Fineness modulus of steel dross=319/100
=3.19

B. Characteristics of Concrete

Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the aggregate particles and glues them together. In its simplest form, concrete is a mixture of paste and aggregates. The paste, composed of Portland cement and water, coats the surface of the fine and coarse aggregates.

Concrete is the world's most important construction material. The quality and performance of concrete plays a key role for most of the infrastructures including commercial, industrial, residential and military structures, dams, power plants and transportation systems

The worldwide use of concrete materials accounts for nearly 780 billion dollars in annual spending. The ability of concrete to be cast to any desired shape and configuration is an important characteristic that can offset other shortcomings. Good quality

concrete is a very durable material and should remain maintenance free for many years when it has been properly designed for the service conditions and properly placed. Of course, proper use of the structure for the intended function can have a significant role.

Through choice of aggregate or control of paste chemistry and microstructure, concrete can be made inherently resistant to physical attack, such as from cycles of freezing and thawing or from abrasion and from chemical attack such as from dissolved sulfates or acids attacking the paste matrix or from highly alkaline pore solutions attacking the aggregates.

Judicious use of mineral admixtures greatly enhances the durability of concrete. The main advantages of concrete as a construction material are the ability to be cast, being economical, durability, fire resistance, energy efficiency, on-site fabrication and its aesthetic properties. Whereas the disadvantages are low tensile strength, low ductility, volume instability and low strength to weight ratio

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

Table – 2
Experimental Results and Discussions

S.NO	*TYPE OF MIX (% OF REPLACEMENT)*	*Flexural strength(N/mm2)*			
		7 days	*28 days*	*60 days*	*90 days*
1	*S0*	*3.8*	*4.94s*	*5.43s*	*5.70s*
2	*S10*	*4*	*5.2*	*5.72s*	*6.00s*
3	*S20*	*4.2*	*5.46*	*6.00s*	*6.30s*
4	*S30*	*4*	*5.2*	*5.72s*	*6.00s*

V. CONCLUSIONS

1) The experimental results shows that the steel dross is can be used as an aggregate for the production of high density concrete by replacing the fine aggregate in different proportions. It was feasible to produce a density up to 2620 kg/m3 by using the steel treatment waste (steel dross).
2) The compressive strengths for S0, S10, S20 and S30 were 27.93N/mm2, 25.86 N/mm2, 27.36 N/mm2 and 28.06 N/mm2 respectively.
3) There is no much increment in the strength almost by average all the results of compressive strength are similar this due to the smooth surface of iron dross which would not provide good zone of contact with the cement.
4) The steel with concrete will provide ductility to the concrete which may results in increasing the flexural strength of the concrete. Compared to the conventional concrete mix there is 12% in the S30 mix.
5) The High Density Concrete is a good solution for Nuclear structures(Power Plants), Vaults, Radiotherapy rooms.
6) High Density Concrete uses heavy natural aggregates such as barites or magnetite or manufactured aggregates such as iron or lead shot. The main land-based application is for radiation shielding (medical or nuclear)
7) The density achieved will depend on the type of aggregate used.
8) Typically using barites the density will be in the region of 3,500kg/m^3, which is 45% greater than that of normal concrete, while with magnetite the density will be 3,900kg/m^3, or 60% greater than normal concrete.
9) Very heavy concretes can be achieved with iron or lead shot as aggregate, 5,900kg/m^3 and 8,900kg/m^3 respectively.
10) Cement contents and water/cement ratios are similar to those for normal concretes, but the aggregate/cement ratios will be significantly higher, because of the higher density of the aggregates.
11) High Density concrete can be batched, transported and placed using conventional equipment, though there are obviously certain aspects, such as the amount that can be carried by a ready-mixed truck or handled in a skip, that will be limited by the density.
12) Because of the higher density, formwork pressures will be increased. The rate of wear of mixers and pumps will also be increased.
13) Compaction will require more energy than normal concrete and poker vibrators will have to be inserted at closer centers. There may be a greater tendency for the mix to bleed.

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