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# Use of Industrial Waste in Concrete

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***Abstract*** **- The utilization of industrial waste materials like Fly ash, Copper slag, Steel slag, Pons ash, Blast Furnace slag etc. in concrete is gradually gaining significant importance in India considering the disposal, environment problems and gradual depletion of natural resources. These waste materials help to improve the properties of fresh concrete like workability, bleeding etc. It also increases Compressive and Flexure Strength of harden concrete specially when use as alternative of fine aggregate.**

***Keywords*** **-** Concrete, Fly ash, Copper slag, Steel slag, Pond ash, Blast Furnace slag

## I. INTRODUCTION

Concrete is known as one of the most versatile building material. Its flow-ability makes it most widely used construction material as its flow-ability in most complicated form i.e. its ability to take any shape while wet, and its strength development characteristics when it hardens. Generally concrete is used to build protective structures, which are subjected to several extreme stress conditions. Concrete is the most widely used construction material manufactured at the site. It is the material where strength, durability, impermeability and abrasion resistance are required. The rapid Industrialization and Urbanization in our country demands the use of large amount of concrete. The sand represents the natural and expensive component of a concrete mixture. The global consumption of natural sand is very high, due to the extensive use of concrete. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructural growth, in this situation developing country like India facing shortage in good quality natural sand [Amnon, K., and Hadassa, B., 2006, Safiuddin et. al, 2007]. The major challenge is the preservation of this natural material by utilization of Industrial waste like Fly ash, Pond ash, Blast furnace slag, Copper slag etc., in concrete as a supplementary material.

## II. TYPES OF SAND

### NATURAL SAND

Natural sand gets eroded from mountain rocks and is mined from the place of deposition. The rocks from where it has eroded, determine its exact mineral composition, however mostly sand is composed of silica, from broken down quartz crystals. This type of sand is extremely resistant to weathering and breakdown due to its chemical hardness, and will last longer as arena footing. These hard sand particles have been transported and tumbled by water, and the time spent tumbling determines an angular or round grain shape. (Vijayaraghavan Nimitha and Wayal A S, 2013)

### MANUFACTURED SAND

Manufactured sand, as also known as Man-made Sand, Crusher Fines, or Stone Dust are the smallest particles is crushed rocks into various sizes called ‘fines’ and sold as Manufactured Sand. These particles range from 5 mm to fine dust, are sharp and will tightly compact if used alone. The mineral composition can range widely, and these particles are not the hard “surviving” quartz grains of tumbling river action, so they may be softer and break down to

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dust sooner. (Vijayaraghavan Nimitha and Wayal A S, 2013)

## III. NATURAL SOURCES OF SAND

Sand is formed by weathering of rocks. Base on the natural sources from which sand is obtained, it is classified as follows:

- Pit Sand
- River Sand
- Sea Sand

### PIT SAND

This type of sand is usually excavated about 1-2 m from the ground level and forming pit in soil. This sand is found as deposits in soil & it consists of sharp angular grains, which are free from salts. It is rated as an excellent material for mortar or concrete work. Pit sand must be free from clay and other organic materials before it can be used in mortar. Also, the coating of oxide of iron over the sand grains should be removed.

### RIVER SAND

Most commonly used river in Indian context is River sand. It is obtained from the banks or beds of river and it consists of fine, rounded grains. The presence of fine rounded grains is due to mutual attrition under the action of water current. The river sand is available in clean condition & white in colour naturally.

### SEA SAND

As the name itself talks about its origin, i.e. sea shores. It consists of fine rounded grains like the river sand. It is light brown in colour since it is contain salts which attract the moisture from the atmosphere. Such adsorption causes dampness, efflorescence and disintegration of work. Sae sand increases setting time of cement. Because of presence of salt in its composition, it is not recommended for engineering applications however by removing salts it can used as local material.

## IV. CLASSIFICATION OF SAND

Based on grain size distribution sand is classified as fine, coarse and gravelly as explained below -

### FINE SAND

The sand passing through a sieve with clean opening of 1.5875 mm is known as fine sand.

### COARSE SAND

Sand passing through a sieve with clean opening of 3.175 mm is known as coarse sand. It is generally used for masonry work.

### GRAVELLY SAND

The sand passing through a sieve with a clean opening of 7.62 mm is known as gravelly sand. It is generally used for concrete work.

The constituents of raw white silica sand is given in Table 4.1.

| **Constituents** | **%** |
|---|---|
| SiO2 | 91.5 |
| Fe2O3 | 1.4 |
| TiO2 | 0.74 |
| Al2O3 | 4.22 |
| Na2O | 0.16 |
| K2O | 0.01 |
| CaO | 0.6 |
| LOI | 1.37 |
| Specific gravity of raw sand | 2.83 |

*Table 4.1 - Chemical analysis of raw white silica sand (Sundararajan M. et al, 2009)*

## V. FUNCTIONS OF SAND IN MORTAR AND CONCRETE

Sand is used in mortar and concrete for following functions: - *(Goncalves et. Al 2007)*

### STRENGTH

It helps in the adjustment of the strength of mortar and concrete by variation of its proportion with cement or lime. It also increases the resistance of mortar against crushing.

### BULK

It acts as an adulterants. Hence the bulk or volume of mortar is increased which result in reduction of cost.

### SETTING

In the case of fat lime, $CO_2$ is absorbed through the voids of sand and setting of fat lime occurs effectively.

### SHRINKAGE

It prevents excessive shrinkage of mortar in the coarse of drying and hence the cracking of mortar during setting time is avoided.

### SURFACE AREA

It subdivides the paste of the binding material into a thin film and thus more surface area is offered for its spreading and adhering.

## VI. ALTERNATIVES OF SAND

Sand is naturally available construction material, its production cannot be controlled however the consumption is controllable through exploration of its alternatives. By using its alternative we can partially or fully replace sand from concrete. There are several type of alternatives are used as alternatives of sand like waste material, manufactured or artificial sand, foundry sand, copper slag, pond ash, furnace slag etc. For this study the selected alternatives are as follows-

### COPPER SLAG

Copper slag is a by-product obtained during matte smelting and refining of copper. The common management options for copper slag are recycling, recovering of metal, production of value added products such as abrasive tools, roofing granules, cutting tools, abrasive, tiles, glass, road-base construction, railroad ballast, asphalt pavements. Inspite of increasing rate of reusing copper slag, a huge amount of its annual production is disposed in dumps or stockpiles to date. One of the greatest potential applications for reusing copper slag is in cement and concrete production. Many researchers have investigated the use of copper slag in the production of cement, mortar and concrete as raw materials for clinker, cement replacement, coarse and fine aggregates. The use of copper slag in cement and concrete provides potential environmental as well as economic benefits for all related industries, particularly in areas where a considerable amount of copper slag is produced. *(Khalifa et. al, 2009)*

### POND ASH

Pond Ash is obtained during the combustion of pulverized coal at the Thermal Power Station the product formed are bottom ash, fly ash and vapours. There bottom ash is that part of residue which is fused into particles and is collected at the bottom of the furnace. The distribution between bottom ash and fly ash fraction is a function of burner type, type of coal and the type of boiler bottom (wet or dry). In India most of the Thermal Power Plants adopt wet method of ash disposal. The fly ash collected from Electrostatic precipitator and the bottom ashes are with water and disposed in a slurry form in large ponds and dykes. Fly ash acts both as a fine aggregate and as a cement. Pond ash differs from fly ash collected from Electrostatic precipitators in a dry form in that it contains significant amount of relatively coarser particles (greater than 45 µm and up to 150 µ m). *(Arumugam, 2011)*

### BLAST FURNACE SLAG

One of the residuals produced from steel plants is Granulated blast furnace slag. Utilisation of waste is a potential alternative to disposal. It serves purposes in that disposal cost and at the same time potential pollution problems are reduced. Nowadays the use of slag in concrete, either as a constituent of cements or as a mineral admixture, is widespread. The granulated blast furnace slag has low resistivity, and so can be used as an agent for reducing resistance to grounding. The grounding resistance reduction agent was determined by considering various proportions of water, cement and sand. *(Chen, 2004)*

## VII. CONCLUSION

The fine aggregates or sand used is usually obtained from natural sources specially river beds or river banks. Now-a-days due to constant sand mining the

natural sand is depleting at an alarming rate. Sand dragging from river beds has led to several environmental issues. Government has banned the dragging of sand from rivers. This has led to a scarcity and significant increase in the cost of natural sand. There is an urgent need to find an alternative to river sand. The only long term replacement for sand is Industrial waste like Cooper Slag, Pond Ash, Blast Furnace Slag etc. Presently, it has no applications and dumped haphazardly on the costly land available near the plants.The industrial waste materials help to improve the properties of fresh concrete like workability, bleeding etc. It also increases Compressive and Flexure Strength of harden concrete specially when use as alternative of fine aggregate.

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