CHARACTERISTICS OF IRON-SILICATE FINES AS REPLACEMENT MATERIAL IN CEMENT CONCRETE

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From waste materials to concrete admixtures

Concrete is the most widely used construction material in the world. It is a homogeneous composite, which contains heterogeneous materials:

- binder - mostly cement;
- aggregates (both sand and gravel) (70% of the volume of concrete);
- water;
- chemical additives.

Main reasons for utilizing industrial waste in concrete and mortar as fine aggregates or substitutes for cement:

- counteracting the decrease of natural resources;
- reducing the cost of construction materials;
- solving the problem of disposal of waste materials, generated by different industries;
- improving the properties of composite materials - both in fresh and hardened state.

Industrial waste are used as a mineral admixtures in the form of:

- blended cements or
- added directly as admixtures to the fresh concrete mix at the time of mixing.

Industrial wastes also called “Mineral Admixtures” or ‘Supplementary Cementing Materials’ and can be divided into two groups:

- cementitious materials - have cementitious properties by themselves.
- pozzolanic materials - exhibit cementitious properties when combined with calcium hydroxide (lime).

Commonly used mineral admixtures, obtained by different types of industrial production, to partially or fully replace cement or sand in concrete and mortar production are:

- steel slag,
- blast furnace slag,
- ground granulated blast furnace slag
- coal bottom ash,
- fly ash,
- silica fume,
- metakaolin
- copper slag,
- iron-silicate fines,
- waste foundry sand,
- imperial smelting furnace slag, etc.

Most of these wastes are well-known and successfully applied in the concrete industry, except for iron-silicate fines, which are relatively unknown in practice.

Characteristics of iron-silicate fines as a fine aggregate in concrete

Iron-silicate fines (ISF) are a waste material, generated by flotation of copper slag (both by furnaces and converters) during the metallurgic production process in the copper plant of Aurubis Bulgaria.

The material has dark angular particles with rough texture and irregular shape. These physical characteristics of ISF reflect positively on adhesion with other aggregates in concrete.

Characteristics of iron-silicate fines:

- 8–12 mm size fraction
- Bulk iron-silicate fines
- Chemical composition of iron-silicate fines

<table>
<thead>
<tr>
<th>Element</th>
<th>Typical content</th>
<th>Range</th>
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<tbody>
<tr>
<td>Fe</td>
<td>46.0 %</td>
<td>44 – 48 %</td>
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<tr>
<td>MgO</td>
<td>27.0 %</td>
<td>26 – 28 %</td>
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<tr>
<td>Al2O3</td>
<td>12.5 %</td>
<td>12.3 – 12.7 %</td>
</tr>
<tr>
<td>CaO</td>
<td>1.8 %</td>
<td>1.3 – 2.5 %</td>
</tr>
<tr>
<td>SiO2</td>
<td>0.7 %</td>
<td>0.6 – 1.1 %</td>
</tr>
<tr>
<td>Cu</td>
<td>0.42 %</td>
<td>0.36 – 0.49 %</td>
</tr>
<tr>
<td>S</td>
<td>0.16 %</td>
<td>0.27 – 0.50 %</td>
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</tbody>
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ISF contain mostly ferrous and silicate oxides (Fe2O3 in the form of fayalite (Fe2SiO4) and magnetite (Fe3O4), together with smaller quantities of aluminium, calcium and magnesium oxides.

The physical and chemical characteristics of ISF reflect positively on adhesion with other aggregates in concrete.

Conclusions

The physical and chemical characteristics of ISF do not differ from those of other waste materials used in concrete production, which makes it a perspective material in that field of application. As a new material, it should first be tested in a laboratory and then on an industrial scale. Different tests related to sand and cement substitution will prove the presence or absence of pozzolanic activity of ISF. The use of ISF in concrete will open up new undiscovered areas of their application and will partially solve the problem of their deposition.

References