METHOD OF PREPARING FRESH CONCRETE FOR CORROSION-RESISTANT REINFORCED CONCRETE

The invention relates to a method of preparing fresh concrete for corrosion-resistant iron-reinforced concrete, wherein the iron reinforcement is protected against corrosion by adding an oxidising agent and a base. After an iron reinforcement has been imbedded in the fresh concrete and the fresh concrete has set, it protects the iron reinforcement against corrosion. The invention also relates to a method of manufacturing corrosion-resistant iron-reinforced concrete using the fresh concrete of the invention.
Method of preparing fresh concrete for corrosion-resistant reinforced concrete

The present invention relates to a method of preparing fresh concrete for corrosion-resistant reinforced concrete.

Concrete is a construction material comprising cement, water, a fine aggregate and a coarse aggregate. Aggregates are of natural origin or are produced artificially. Natural aggregates are, among others, sand and gravel that are dredged from the river and from the sea. In addition, there is crushed stone, usually obtained from a stone pit. Artificially produced (light) aggregates are, among others, expanded clay and sintered fly ash. Fine aggregate is aggregate in which the maximum grain diameter is 4 mm or smaller. Coarse aggregate is aggregate in which the maximum grain diameter is larger than 4 mm. The capacity of concrete to absorb compressive loads is excellent, but for the absorption of tensile strain the concrete needs to be reinforced. This reinforcement may be pre-stressed. The cheapest form of reinforcement is iron-based reinforcement. The problem with such reinforcement is that it is susceptible to corrosion.

The object of the present invention is to provide a method of preparing fresh concrete suitable for corrosion-resistant iron-reinforced concrete, wherein the iron reinforcement is protected against corrosion.

To this end the present invention provides a method of preparing fresh concrete for corrosion-resistant iron-reinforced concrete, characterized in that the iron reinforcement is protected against corrosion by adding an oxidising agent and a base.

The fact that the combination of oxidising agent and a corrosive substance that is a base, can result in protection of the iron reinforcement of concrete, is certainly surprising.

Prior to, or at the moment of preparing the fresh concrete (preparing entails the addition of water), the
oxidising agent and/or the base may be admixed to one or several of the starting materials of concrete. It goes without saying that the fresh concrete may also comprise further typical additives such as pigment, set-influencing substances (set-retarding or -accelerating additives), fibres (steel fibres etc.) and fillers (coal-dust fly ash, lime-stone powder, silica fume, trass, blast-furnace slag). In the present application, the term iron reinforcement is understood to refer to any reinforcement of iron or an alloy thereof. This includes, for example, steel. The reinforcement may have any shape, such as mesh or cables. If desired, the reinforcement may be pre-stressed.

The Russian patent publication RU 2165911 discloses a mortar comprising a nitrate and calcium hydroxide. While mortar is not a construction material, it is useful for finishing a construction material such as concrete or bricks. There is nothing in this publication to suggest the possibility that the use of an oxidising agent and a base, even if they are able to come in contact with iron-based reinforcement, could render this reinforcement corrosion-resistant.

As oxidising agent one usually uses a nitrate in accordance with the invention, and preferably an alkaline-earth metal nitrate such as calcium nitrate. As base one usually uses a hydroxide, preferably an alkaline-earth metal oxide, most preferably calcium oxide.

The use of an alkaline-earth metal is preferred because it does not affect the colour of the concrete, and avoids the use of environmentally harmful heavy metals. Calcium is preferred because it plays a role in the hydration, which has a positive effect on the development of strength. The use of hydroxide as base is preferred because it dissolves quickly despite the already basic nature of the fresh concrete.

In accordance with the invention, the nitrate is added in an amount of 0.35 to 35 kg, and preferably in an amount of 3.5 to 15 kg per cubic metre of fresh concrete. The hydroxide is added in an amount of 0.20 to 20 kg, and pref-
erably in an amount of 3.5 to 15 kg per cubic metre of fresh concrete.

The invention also relates to a method of manufacturing corrosion-resistant iron-reinforced concrete, in which an iron reinforcement to be protected against corrosion is embedded in the fresh concrete prepared in accordance with one of the claims, whereafter the fresh concrete with the iron reinforcement embedded therein is allowed to set. In this manner reinforced concrete is obtained, whose iron-based reinforcement is less susceptible to corrosion.

The invention will now be elucidated by way of exemplary embodiments.

Exemplary embodiments

Example 1

For a bridgesroad 1 m³ corrosion-resistant concrete was manufactured. The corrosion-resistant concrete had to meet the following requirements:
Strength class: C35/45
Environmental classes XC4, XD3 & XF4
Consistency range: F4

Per cubic metre of fresh concrete the following ingredients were used in the amounts given:

- 280 kg CEM III/B 42.5N
- 80 kg CEM I 52.5R
- 60 kg coal-dust fly ash
- 162 litres water (effective)
- 958 kg river gravel 4-16 mm (incl. 1.84% total moisture)
- 818 kg river sand 0-4 mm (incl. 3.26% total moisture)
- 1.7 kg Pozzolith 380R (set-retarding additive)
- 2.1 Rheobuild 1100-30 (plasticising additive)
- 24.2 kg calcium nitrate tetrahydrate (oxidiser)
- 16.8 kg calcium hydroxide (base)

The ingredients were weighed accurately using installations suitable for that purpose, i.e. an automatic weighing machine or a computer-controlled weighing installation. The ingredients were added practically simultaneously in a free-fall mixer. The ingredients were mixed for approx.
30 seconds (depending on the quantity and cement characteristics) to form a homogenous fresh concrete. In the free-fall mixer the ingredients were lifted through rotation, and then dropped in a free fall. In this way the ingredients were mixed to form a homogenous mass. The volume of the free-fall mixer is 6 m³ but may vary from 4-6 m³. During mixing, the free-fall mixer operated at approx. 10 revolutions per minute.

Example 2

For a retaining wall 1 m³ corrosion-resistant concrete was produced. The corrosion-resistant concrete had to meet the following requirements:

Strength class: C20/25
Environmental classes XC4; XD3; XA2; XF2

Consistency range: S3

Per cubic metre of fresh concrete the following ingredients were used in the amounts given:

- 350 kg CEM III/B 42.5N
- 160 litres water (effective)
- 1020 kg river gravel 4-32 mm (incl. 2.51% total moisture)
- 860 kg river sand 0-4 mm (incl. 2.98% total moisture)
- 1.75 Rheobuild 1100-30 (plasticising additive)
- 25.2 kg calcium nitrate tetra hydrate (oxidiser)
- 14.0 kg calcium hydroxide (base)

The ingredients were accurately weighed using suitable installations, i.e. an automatic weighing machine or a computer-operated weighing installation. All the ingredients except for the gravel were added practically simultaneously into a forced concrete mixer with vertical shaft. The ingredients were mixed for approx. 20 seconds (depending on the batch size and cement properties) to form a homogenous slurry. In this forced concrete mixer with vertical shaft the ingredients undergo forced mixing. In this manner they were mixed to form a homogenous mass. The homogenous slurry was unloaded into a truck mixer while simultaneously (outside the mixer) a quantity of the gravel is metered into the truck mixer. Mixing in the truck mixer was completed after approx. five minutes, resulting in a homogenous fresh concrete.
Example 3

Preparation of corrosion-resistant reinforced concrete

After preparation and an optional quality inspection, the fresh concrete may be transported to the site of fabrication into reinforced concrete. This may be accomplished in a manner well known to the person skilled in the art.

The fresh concrete may be poured, for example, into a formwork, for instance via a trough, using a tub or a concrete pump. The fresh concrete may subsequently be compacted, for example, with a needle vibrator. After filling the formwork with (compacted) concrete and, optionally, finishing it, the concrete is cured. This is essential for corrosion-resistant concrete. Curing may take place by covering the concrete so as to prevent the evaporation of water. It is also possible to apply a curing component to the concrete, for example, by spraying.

When the fresh concrete has attained the necessary strength, the construction has acquired load capacity. In general practice a period of, for example, approx. 28 days is allowed.
CLAIMS

1. A method of preparing fresh concrete for corrosion-resistant iron-reinforced concrete, characterized in that the iron reinforcement is protected against corrosion by adding an oxidising agent and a base.

2. A method according to claim 1, characterized in that the oxidising agent is a nitrate.

3. A method according to claim 2, characterized in that the nitrate an alkaline-earth metal nitrate.

4. A method according to claim 3, characterized in that the alkaline-earth metal nitrate is calcium nitrate.

5. A method according to one of the preceding claims, characterized in that the base is a hydroxide.

6. A method according to claim 5, characterized in that the hydroxide is an alkaline-earth metal hydroxide.

7. A method according to claim 6, characterized in that the alkaline-earth metal hydroxide is calcium hydroxide.

8. A method according to one of the preceding claims, characterized in that the nitrate is added in an amount of 0.35 to 35 kg nitrate per cubic metre of fresh concrete.

9. A method according to claim 8, characterized in that the nitrate is added in an amount of 3.5 to 15 kg nitrate per cubic metre of fresh concrete.

10. A method according to one of the preceding claims, characterized in that the hydroxide is added in an amount of 0.20 to 20 kg hydroxide per cubic metre of fresh concrete.

11. A method according to claim 10, characterized in that the hydroxide is added in an amount of 3.5 to 15 kg hydroxide per cubic metre of fresh concrete.

12. A method of manufacturing corrosion-resistant iron-reinforced concrete, characterized in that an iron reinforcement to be protected against corrosion is embedded in the fresh concrete prepared in accordance with one of the
preceding claims, whereafter the fresh concrete with the iron reinforcement embedded therein is allowed to set.