Flame treatment of concrete for finishing or cleaning

Swedish studies evaluate the efficiency and effects of the process

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Flame treatment is a relatively new method of cleaning concrete or roughening its surface. The flame treatment of concrete has four main applications:

- to pretreat the surface to achieve the best possible bond of a paint, plastic or other applied coating
- to clean the surface of oil or other stains
- to expose the coarse aggregate for aesthetic reasons
- to increase the friction of roads and landing strips

The process involves moving a special multiflame blowpipe with an oxygen-acetylene flame over the surface at a uniform speed. Due to the high temperature of the oxyacetylene flame (approximately 5600 degrees F)[1]* and the high working pressure of the gases, a combination of thermal and mechanical cleaning is achieved. Oils, paints and other organic impurities are burned away, moisture in the surface of the concrete is evaporated and a surface layer is melted or spalled off. The pressure of the gas is great enough to blow most of the burnt residue away. Any remaining residue can easily be removed mechanically using a rotating wire brush, surface scaler or the like. In this article we use the term flame cleaning to apply to removal of organic materials such as oil and paint, flame finishing to apply to removal of a portion of the concrete surface, and flame treatment to cover both aspects.

Swedish Research Institute tests

Naturally it must be guaranteed that the relatively high temperature of the flame will have no deleterious effects on the concrete. The Swedish Cement & Concrete Research Institute has recently completed a major study involving both field and laboratory tests to determine both the effects of flame treating and the influence of the speed of the blowpipe. For the majority of the studies a large blowpipe outfit was used, approximately 20 inches[2] wide, mounted on a special carriage with two wheels and a forward drive mechanism. A smaller, manually operated outfit having a width of 6 inches[3] was used for testing painted and plastic coated concrete and for trials with exposed aggregate concrete. The most important findings of the study can be summarized as follows:

This flame-treating unit moves forward by means of a chain drive operated by a hand crank. Pressure gages and flame controls are on handle.

Thickness of concrete removed

The thickness removed depends on the speed of the blowpipe and the properties of the concrete. The most suitable blowpipe speed lies between ¾ and 1¼ inches[4] per second. Of all the properties of the concrete, moisture content has the greatest effect on concrete removal. Completely dry slabs contained large areas where flame finishing had not removed the material. Slabs that were soaked with water for several hours before flame finishing exhibited uniform removal results. Aggregate type, compressive strength and age of the concrete had no significant effect on the results of flame finishing.

* Numbers in parentheses refer to metric equivalents listed with this article.

Temperatures

Temperatures higher than about 390 to 480 degrees F,[5] which have a deleterious effect on concrete, were reached only in the uppermost 0.078 inch[6] of the concrete at normal blowpipe speeds. At lower depths, temperatures were substantially lower; for example, at 0.28 inch[7] below the surface, the temperature reached a maximum of only about 158 degrees F.[8]

Tensile strength

Beams sawed from flame-treated slabs had a somewhat lower tensile strength in bending. But as this difference was of small magnitude in relation to the spread of the measured values, it has no practical significance.

Frost resistance

Tests carried out on concrete possessing good resistance to frost showed that, after flame treatment, the concrete retained its good frost resistance.

Practical conclusions

The practical conclusions that can be drawn from these studies are as follows:

Cleaning effect

The laitance layer is removed to a depth of 0.040 to 0.080 inch.[9] Paint layers of average thickness and plastic coatings 40 to 80 mils[9] thick can be removed without problems. The surfaces of oil-stained slabs can be flame-cleaned so effectively that plastic coatings can be applied directly to the concrete.

Bond

Flame-cleaned concrete forms an excellent bond with either portland cement mixes or epoxy resin. Flame treating greatly improves this bond, especially on slabs with thick laitance layers. Flame-cleaned oil-stained concrete slabs form a full-strength bond to epoxy resin.

Physical properties

Flame treatment performed at normal blowpipe speed does not have any significant deleterious effects on the essential properties of concrete.

The nature of the concrete

Very dry concrete or concrete possessing a thick laitance layer is more difficult to flame-finish. Wetting the concrete thoroughly about an hour before flame finishing improves surface scaling on any surfaces which would otherwise be difficult to flame-finish because of low moisture content.

Execution

The results of flame treating are dependent to a high degree on its execution. This means that the personnel who are to execute flame treating must have some training and education. Heat generation is relatively high, which can give rise to problems in cramped areas where there is little ventilation or with materials or installations that are temperature-sensitive. Walls and columns, however, can be effectively protected by a layer of heat-resistant material. Protective clothing, including gloves and face protection, should be worn by personnel performing flame treatment.

Highway traffic markings are readily removed.

Flame-treating operations

Experience has proved that the most efficient equipment for flame treating large surfaces is the 20-inch[10] unit. Its blowpipe has 24 nozzles and there are three acetylene and two oxygen supply lines to the blowpipe. Movement of the carriage on which the blowpipe is mounted is effected by means of a hand crank connected to the wheels by a chain drive. Adjustment of blowpipe height is made by rotating a knob at steering level. Normally the nozzles can be blown clean by means of the oxygen supply; otherwise, particles that stick should be removed with a brush having brass or similar bristles. If a nozzle is completely clogged, it can be disassembled and cleaned carefully with a needle, but damaged nozzles should be replaced to ensure the best flame-treating result and maximum gas economy.

The large 20-inch[10] unit is most economical for use on areas of more than 1070 to 2150 square feet.[11] For smaller areas a 10-inch[12] unit is recommended, and for very small areas and vertical surfaces a 6-inch[13] torch is most efficient. The 20-inch[10] blowpipe on a carriage permits removing material at a higher rate but also removes it more deeply.

Before beginning a job, it is best to determine the optimum direction and pattern of flame treating for site limitations and other job conditions. In particular, the best location for the gas cylinders should be determined to avoid unnecessary movements. Hose lines should be as short as possible, and, to limit pressure-drop, must

not exceed 196 feet.[14] It is also vitally important to assess the fire dangers inherent in the use of an open flame. Local fire regulations must be observed. Proper ventilation of the area is also essential, particularly if the burning-off of old coatings can generate noxious gases.

A flame-treating blowpipe should be ignited with a lighter specially made for the purpose. Cigarette lighters and matches can lead to burned fingers. The flame of the 10-inch[12] and 6-inch[13] units must be adjusted so that there is a hard flame, that is, a flame with 20 to 30 percent excess of oxygen. This flame is characterized by its sharply defined, pointed shape, its shorter-than-normal flame, and its bluish core. There must never be an excess of acetylene (uneven flame with long red and yellowish streaks); otherwise the surface will receive a deposit of soot. This kind of flame also reduces heat output and impairs combustion of organic impurities. The nozzle flames of the 20-inch[10] unit should be adjusted so that they have pointed, sharply defined edges with blue-colored centers. With the blowpipe carriage, the angle of impact of the flame should be approximately 45 degrees; with the smaller, handheld blowpipes an angle of approximately 30 degrees is usually most suitable for flame treatment.

A trial run over a few square feet[15] of surface is usually sufficient to establish the correct flame pressures and speed of movement. It is comparatively easy to determine the minimum conditions under which the surface is steadily, but not violently, blown clean of laitance and contamination.

Metric equivalents

(1) 3100 degrees C
(2) 500 millimeters
(3) 150 millimeters
(4) 20 and 30 millimeters
(5) 200 to 250 degrees C
(6) 2 millimeters
(7) 7 millimeters
(8) 70 degrees C
(9) 1 to 2 millimeters
(10) 500-millimeter
(11) 100 to 200 square meters
(12) 250-millimeter
(13) 150-millimeter
(14) 60 meters
(15) a square foot is about 0.1 square meter

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