In-situ test methods for assessment of surface pH of corroding sewer pipes
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ABSTRACT:
A method for measuring the surface pH of corroding concrete was developed in the lab and tested in the field. The method is based on direct application of pH indicator solution on the corroding surfaces. Comparison against point measurements using a flat surface pH electrode (flattide) confirmed the accuracy of the method. Blind testing of concrete specimens exposed to different acid concentrations demonstrated that it was possible to determine the surface pH within ±0.5 pH units in the pH range of one to five. The developed method provides a simple and reliable estimate on the extent of concrete corrosion. Relatively large surface areas, e.g. an entire sewer manhole, can be sprayed and assessed within a matter of minutes.

RESULTS AND DISCUSSION

METHOD DEVELOPMENT

Samples of corroding concrete were collected in the field (Fig. 2a). In addition, a number of concrete blocks (5 x 5 x 5 cm) were cut from sewer pipe and submerged in sulfuric acid solutions of different pH (0; 0.001; 0.01 and 0.1 M H₂SO₄) for a period of six months. For analysis, the samples were sprayed with the selected pH indicators and the surface pH was measured using a flat electrode (Fig. 2b). After rigorous testing, it was concluded that a 50/50% (v/v) mixture of bromocresol green (CAS # 76-60-8) and thymol blue (CAS # 76-61-9) in 50% ethanol provided the best discrimination of different stages of concrete corrosion (Fig. 2c).

Figure 2. a) Sampling of corrosion products from a sewer manhole; b) application of a flat surface pH electrode; c) relationship between colour of the indicator and pH in the range 1-10.

The (corroding) concrete can attain different colours according to the state of corrosion, composition of the cement and type of aggregate material used, etc. This can complicate the assessment of the surface pH. It was therefore attempted to enhance the colour by digital image processing techniques. For this purpose, a set images were taken before and after application of the pH indicator. Subsequently, the two images were merged using different filter algorithms (Fig. 3).

As evident from Figure 3, it is possible to enhance the colour by digital filtering. Preliminary testing has indicated that the method gives best results on a greyscale background (before image).

APPLICATION IN THE FIELD

The pH indicator was tested in a number of sewer manholes located downstream of force mains. The mixture was sprayed onto the concrete surfaces by means of a pressurized tank sprayer with fine mist nozzle. Within a few seconds of application, the concrete developed a color according to the surface pH (Fig. 4a and b).

Figure 4. Before (a) and after (b) application of the pH indicator mixture in a corroding sewer manhole located downstream of a 1800 m long force main.

The example demonstrates that it is possible to estimate the surface pH even without digital image processing. Also, the results show that a significant pH gradient can exist within a single manhole. In the areas with a low surface pH (≤ 3), the aggregates of the concrete are clearly visible. Similar observations of a pH gradient has been reported by Satoh et al. (2009) who measured the surface pH at four different positions in a sewer manhole. The method provides a simple way of assessing the status of a corroding sewer pipe. Manholes can be sprayed from above ground using simple equipment and evaluated within a matter of minutes. The method has potential to be combined with CCTV pipe inspection.

REFERENCES

• BS EN 14630:2006 Products and systems for the protection and repair of concrete structures. Test methods. Determination of carbonation depth in hardened concrete by the phenolphthalein method.


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