Standard Method of Test for

Comparative Qualitative Corrosion Characterization of Uncoated Chromium-Alloyed Steel Bars Used for Concrete Reinforcement (Tombstone Test)

AASHTO Designation: T 374M/T 374-17[1]

Technical Section: 4f, Metals

Release: Group 2 (June 2017)

AASHTO

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1. SCOPE

1.1. This test method, the tombstone test, provides a procedure for evaluating and comparing the relative corrosion resistance of different types of steel reinforcement. This test is designed for assessing the corrosion resistance of uncoated chromium-alloyed reinforcing steel bars as compared to carbon steel bars or other selected reference bars if indicated by the purchaser.

Note 1—This test method was developed for use in marine substructure applications; however, it may be applied to other non-marine environments subject to deicing salts such as concrete substructure and super structure elements. Agencies should review its use related to their climatic and geographic regions in other corrosion susceptible applications.

1.2. The values stated in either SI or inch-pound units shall be regarded separately as standard. The inch-pound units are shown in brackets. The values stated might not be exact equivalents; therefore, each system must be used independently of the other.

1.3. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards*:

- M 31M/M 31, Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement
- M 334M/M 334, Uncoated, Corrosion-Resistant, Deformed and Plain Chromium Alloyed, Billet-Steel Bars for Concrete Reinforcement and Dowels
- T 22 Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens
- T 121M/T 121 Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- T 277, Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

2.2. *ASTM Standards*:

- A1035/A1035M, Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement
- C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
- C876, Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete

2.3. *Other Documents*:

- Hartt, W. H., R. G. Powers, D. K. Lysogorski, V. Liroux, and Y. P. Virmani. *Corrosion Resistant Alloys for Reinforced Concrete*. FHWA-HRT-07-039. Federal Highway Administration, Turner-Fairbank Highway Research Center, McLean, VA, 2007.

3. SIGNIFICANCE AND USE

3.1. The purpose of this qualitative test method is to emphasize the key differences between the corrosion behaviors of uncoated corrosion-resistant chromium alloyed reinforcing steels (CRR) as compared to carbon steel, namely the enhanced resistance to chlorides.

3.2. The rating system is designed to place steels in one of four categories or levels (0, 1, 2, and 3). There is no linear relationship between levels. It is more like a tenfold or better difference between levels. If an agency runs the test, the steels will, over time, be distinguishable by groups. The 0 level will have numbers/test values around the same as the control M 31M/M 31 carbon steel black bar. There will be some variability but these bars will be lower than the bars in level 1, which have mild corrosion resistance by having some amount of chromium. There will be a spread or variability depending on what alloys and percentage of alloys are introduced into the steel but after a period of time (months or years) the level 1 bars will hover around the values for A1035CS alloy. The level 2 rating will be associated with the UNS S32101 type alloy steel category, while the high chromium steels, 18 percent chromium UNS S31653 alloy steel, will be associated with level 3.

3.2.1. In laboratories performing this testing, the black bar (steels without corrosion resistant alloys) separate quickly, the low chromium types separate slower and the higher quality stainless, or quality stainless clad, bars can take an extremely long time to show a difference or separate out. The speed of the test is related to quality of concrete and whether the concrete cracks

4. SUMMARY OF METHOD

4.1. This test method cyclically immerses reinforcing steel bars embedded in a block of concrete referred to as a tombstone in a salt water bath for several months or years until corrosion develops.

4.2. The time to corrosion is used to separate types of alloy reinforcing bars into levels of corrosion resistance.

5. TEST EQUIPMENT AND MATERIALS

5.1. *Immersion Tanks*—A suitable immersion tank will most likely be a fiberglass or plastic tank that is resistant to sodium chloride solution and has favorable impact resistance or can be easily repaired if a specimen strikes the tank. For example, the two fiberglass tanks shown in Figure 1 are 28 by 30 by 48 in. and hold 30 specimens each.