



DOH 15

## TESTING OF REINFORCING STEEL

### 1. SCOPE

- 1.1 These methods cover procedures for testing reinforcing steel such as deformed bars and welded wire fabric.
- 1.2 The tension test, described in this DOH relates to the mechanical testing of steel products, performed by subjecting a specimen of the material to a measured load that is sufficient to cause fracture of the material or yielding.

### 2. REFERENCED DOCUMENTS

- 2.1 AASHTO Specifications
  - M31M / M 31-02, Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

### 3. PROCEDURE FOR TESTING DEFORMED BARS

- 3.1 This method shall be used to determine the yield point, ultimate strength, percent elongation, bend test, and weight per foot for bar sizes #3 through #8. For bar sizes equal or greater to a #9 bar, this procedure is applicable only for the yield point, weight per foot, and bend test.
- 3.2 Specimen Requirements
  - 3.2.1 Two test specimens that are approximately 3' (0.9 m) in length of each size and each heat are required for testing.
  - 3.2.2 One specimen is normally tested for tensile strength while the other is tested for bend.

#### 3.3 Test Procedure

- 3.1.1 The tension test specimen shall be gage marked with a center punch with an 8" (20 cm) gage length near the middle of the specimen. *The purpose of the gage mark is to provide reference points for determination of the percent of elongation. Punch marks shall be light, sharp, and accurately spaced (8"  $\pm$  1/16" (20 cm  $\pm$  0.15 cm) gage).*
- 3.1.2 It is the function of the gripping or holding device of the machine to transmit the load from the heads of the machine to the specimen under test. The essential requirement is that the load shall be transmitted axially. This implies that the centers of the action of the grips shall be in alignment, insofar as practical, with the axis of the specimen at

the beginning and during the test, and that bending or twisting be held to a minimum. Gripping the specimen shall be restricted to the section outside the gage length.

3.1.3 The speed of the testing shall not be greater than that at which the load and behavior of the specimen can be properly observed.

3.1.4 Determination of Tensile Properties – Yield Point – Halt of the Pointer Method. In this method and increasing load is applied to the specimen at a uniform rate. The load at which there is a halt or hesitation of the load indicating pointer is noted and termed the “yield point”. The stress at this point is computed and termed the yield stress. Calculate the yield stress by dividing the load at the “yield point” by the nominal cross-sectional area of the test specimen.

3.1.5 Tensile Strength – Calculate the tensile strength of the Deformed Bar by dividing the maximum load the specimen sustains during a tension test by the original cross-sectional area of the specimen. Nominal bar areas as specified in AASHTO M31 shall be used in computations.

3.1.6 Elongation – To determine the percentage of elongation, fit the ends of the fractured specimen together carefully and measure the distance between the gage marks to the nearest 1/8" (0.32 cm). The elongation is the increase in length of the gage length, expressed as a percentage of the original gage length. In reporting elongation values, give both the percentage increase and the original gage length.

3.1.6.1 If any part of the fracture takes place outside of the middle half of the gage length or in the punched or scribed mark within the reduced section, the elongation value obtained may not be representative of the material. If the elongation measured meets the minimum requirements specified, no further testing is needed. However, if the elongation is less than the minimum requirements, discard the specimen and retest a new specimen.

3.1.7 Bend Test – The bend test is one method for evaluating ductility, but it cannot be considered as a quantitative means of predicting service performance in bending operations. The severity of the bend test is primarily a function of the angle of bend and inside diameter to which the specimen is bent, and of the cross-section of the specimen. These conditions are varied according to location and orientation of the test specimen and the chemical composition, tensile properties, hardness, type, and quality of the steel specified.

3.1.7.1 Bend the test specimen at room temperature to an inside diameter, as designated by the applicable product specifications, to the extent specified without major cracking on the outside of the bent portion. The speed of bending is ordinarily not an important factor.

#### **4. PROCEDURE FOR TESTING WELDED WIRE FABRIC**

4.1 This method shall be used for measurement of wire-spacing, wire diameter, reduction of area, ultimate tensile strength, and bend tests.

4.2 Specific requirements for testing welded wire fabric.

4.2.1 Specimen – One section of the wire fabric containing two of the type wires to be tested and approximately 3' (0.9 m) in length shall be required. One wire will be tested for diameter, tensile strength, and reduction of area. The other will be used for the bend test.

4.2.2 The fabric shall be checked for wire spacing dimensions and placement. From this section of fabric, a wire is cut to be tested for tensile strength. It should be cut approximately 23" (58 cm) long and the cuts situated so that the wire will fit into the testing machine with two welds between the holding jaws and no welds within them.

4.2.3 Cut as much as possible of the cross wires without nicking the wire to be pulled. This reduces the chances of binding and slipping in the testing machine.

4.2.4 Measurement of the diameter (to 0.001" (0.03 mm)) of the specimen will be made on that section of the wire that will be between the holding jaws of the pulling machine. From this, the actual diameter and the cross-sectional area are determined.

4.2.5 The wire shall be installed into the testing machine so that the applied load will be transmitted axially and not so that binding or twisting of the specimen will occur.

4.2.6 Loading – Load shall proceed slowly and evenly until the wire fractures.

4.2.7 Determination of the Tensile Properties – After fracture, the maximum load shall be recorded and the diameter at point of fracture shall be measured to 0.001" (0.03 mm) for determination of the reduced area.

4.2.8 If fracture occurs within the holding jaws or at either of the two welds between the holding jaws, and the ultimate strength or reduced area is not within specifications, a new sample shall be taken and retested.

4.2.9 With the original remaining second wire, the bend test shall be performed. The wire may be bent by hand around the correct diameter mandrel.

#### **5. RESULTS**

5.1 The results of the tests shall be summarized and reported on the appropriate form.

5.1.1 Type of material

- 5.1.2 Contract (if applicable)
- 5.1.3 Source
- 5.1.4 Date of sampling
- 5.1.5 Use of material
- 5.1.6 Size, diameter, etc.
- 5.1.7 Weight per foot (rebar only)
- 5.1.8 Yield stress (if applicable)
- 5.1.9 Ultimate tensile strength
- 5.1.10 Percent elongation (bar only)
- 5.1.11 Reduction of area (welded wire only)
- 5.1.12 Bend test results.