

SUPERSEDED BY EI 08-012 EFFECTIVE 3/18/08		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 97-007
Title: SPECIFICATION 16586.20XXYY M AND 16586.20XXYY "DRILLING AND GROUTING ANCHOR BOLTS AND REBARS IN CONCRETE"			
Distribution: ☐ Manufacturers (18) ☐ Surveyors (33) ☒ Main Office (30) ☒ Consultants (34) ☒ Local Govt. (31) ☐ Contractors/AGC (39) ☒ Regions/Agencies (32) ☐ _____ ()		Approved:  J. M. O'CONNELL Deputy Chief Engineer (Structures) 2.27.97 Date	

This EI supersedes EI 84-57.

EFFECTIVE DATE. The titled specification becomes effective on Department contracts let on or after July 10, 1997. However, it is recommended that it be used on earlier projects whenever possible.

AFFECTED SPECIFICATIONS. All current drilling and grouting specifications for work in concrete which include test loading as one of the requirements for acceptance are void after the July 24, 1997 letting date. Specifically voided are specifications 15586.19 and 16586.02.

PURPOSE. This instruction is written to distribute the titled specifications, and void outdated specifications.

BACKGROUND. The titled specifications were written to incorporate the most current knowledge regarding drilling and grouting of anchor bolts and reinforcing bars in portland cement concrete. Henceforth, in this EI the term "anchor" refers to both anchor bolts and rebars. The titled specifications modify provisions of Specification 15586.19 which has been the primary drilling and grouting specification used by the Department when load testing was required. The primary modifications, and the reasons for them are:

1. Serialization of the items will allow for more accurate and efficient compilation of costs. By not serializing Specification 15586.19 all sizes of anchor bolts and rebars were drilled and grouted under one specification. Rebars, due to their ribs, require a larger diameter hole and more grout to place than the same diameter anchor bolt. The diameter of an anchor bolt or rebar also affects the cost of installation. A 25 mm (1") dia. anchor bolt requires a larger diameter hole and more grout than a 13 mm (1/2") dia. anchor bolt. The serialization provides for a different number for each type and size anchor. The methods used to serialize the specifications are as follows:

The third and fourth positions to the right of the decimal place are used to enter the type of anchor being installed. The code numbers are as follows:

- "01" for a fully threaded anchor bolt.
- "02" for a reinforcing bar.

The fifth and sixth positions are used to indicate the diameter of an anchor bolt or the bar designation, depending on which is being installed. This is done in the following manner:

- **Anchor Bolts** - Insert the metric diameter of the anchor bolt in millimeters. When converting US dimensions, use the closest metric (soft converted) diameter. For example, the input numbers for common anchor bolt diameters are:

<u>Dia. of Anchor Bolt</u>		<u>No. To Enter In 4th & 5th Position</u>
• 13 mm (1/2") ϕ bolt	=	13
• 16 mm (5/8") ϕ bolt	=	16
• 19 mm (3/4") ϕ bolt	=	19
• 22 mm (7/8") ϕ bolt	=	22
• 25 mm (1") ϕ bolt	=	25
• 29 mm (1 1/8") ϕ bolt	=	29
• 32 mm (1 1/4") ϕ bolt	=	32

- **Reinforcing Bars** - Insert the metric bar designation being installed. They are:

<u>Bar Designation</u>		<u>No. To Enter In 5th & 6th Position</u>
<u>US</u>	<u>Metric</u>	
3	10	10
4	13	13
5	16	16
6	19	19
7	22	22
8	25	25
9	29	29
10	32	32
11	36	36
14	43	43
18	57	57

Using the latter instructions, the following specification numbers would apply to the following situations:

- #32 (#10) rebar - 16586.200232
- 22 mm (7/8") ϕ anchor bolt - 16586.200122

2. Drilling in concrete is restricted to rotary impact drills. They drill a hole as fast as any other method, and leave no residue in the hole except some dry concrete dust.

Core drilling needs water to cool the drill. This water and the fine concrete dust created by the drill, combine to make a paste that is forced against the side of the hole. As the hole dries out this paste adheres to the side of the hole making its removal difficult.

An impact drill is potentially destructive to the concrete, and drills at a slower rate than the rotary impact drill.

If a rebar is encountered, a core drill shall be used to cut through it. After the rebar is cut, the rest of the hole depth shall be drilled with a rotary impact drill.

3. The titled specification has no lengths of embedment listed. Since Specification 15586.19 was issued, more has been learned about the effects of edge distance and the distance between adjacent anchors regarding the capacity of anchors. This makes it more difficult to determine embedment lengths. Material is being developed to establish a method which will allow designers to determine embedments. However, until a method is established, embedment lengths shall be obtained from this Division's General Structural Engineering Unit. The phone numbers are (518) 485-8554 and (518) 457-2459.

4. The titled specification covers both anchor bolts and reinforcing bars. In the specification there are test load tables for A568M Property Class 8.8 (ASTM A449) anchor bolts and A615M Gr 420 (ASTM A615 Gr. 60) reinforcing bars. These are the most commonly used steels; however, this specification can be used for any type of steel.

5. Only polymer grouts are allowed under this specification. We know of no other practical grout that provides equal or greater pullout strength.

6. The Method of Measurement has been changed from the total linear feet of drilling and grouting of anchors in the project, to the number of locations where an anchor is drilled and grouted. This is made possible by serializing the specification. Now, each location with a particular type of anchor (bolt or rebar) will have its own specification number. This makes it easier to deal with an Order-on-Contract, should it be necessary, since each serialized specification involves one specific anchor type and diameter. Bidding will be more accurate, since each location is unique. Estimating will be easier because the estimator need only count the number of anchors to be installed under each serialized specification.

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For guidelines regarding when to require test loading of anchors, refer to Structures Design Advisory 96-002 titled "Guidelines For Drilling and Grouting Anchor Bolts and Reinforcing Bars, and Embedment Lengths".

In the Structures Design Advisory 96-002 make the following change:

In the first line on page 2, replace "Item 15586.19 titled "Drilling and Grouting High Strength Anchor Bolts" with Item 16586.20XXYY M titled "Guidelines For Drilling And Grouting Anchor Bolts and Reinforcing Bar, and Embedment Lengths".

COST EFFECT. This specification will not have any effect on the cost of drilling and grouting load tested anchors.

CONTACT. Questions regarding this EI should be directed to L.N. Johanson, Structures Division, at [518]-457-2459.

ITEM 16586.20XXYY M - DRILLING AND GROUTING ANCHOR BOLTS AND REBARS IN CONCRETE

DESCRIPTION

The work shall consist of drilling holes into existing concrete, at locations and depths shown on the plans, and grouting anchor bolts or rebars into them. Henceforth in this specification the term "anchor" shall mean either anchor bolt, or reinforcing bar. Drilling shall be done using a rotary-impact drill. If reinforcing steel is encountered it shall be cut with a core drill. The work shall also include providing load test equipment and load testing of anchors designated by the Engineer. The anchors will be paid for under another item.

MATERIALS

The Contractor shall use a grout which meets NYS Standard Specifications, Section 701-07 ANCHORING MATERIALS - CHEMICALLY CURING.

The Contractor is hereby notified that not all approved grouts have the same bond strength nor are they compatible with all concretes. Therefore, it is the Contractor's responsibility to assure the concrete-grout compatibility by pretesting a number of anchors to their test load before starting production grouting. The Contractor shall choose the number of anchors to be pretested to assure concrete-grout compatibility.

CONSTRUCTION DETAILS

Only a rotary impact drill is to be used to drill holes in concrete. If a rebar is encountered, it shall be cut with a core drill. After the rebar is cut, the remainder of the hole shall be drilled with a rotary impact drill.

Drilling shall not cause spalling, cracking or other damage to the concrete. Concrete spalled or otherwise damaged by the Contractor's operations shall be repaired in a manner satisfactory to the Engineer. Such repair shall be done at no additional cost to the State.

Drilling with a lubricant, including detergents, other than water shall not be permitted.

If approved by the Engineer, hole locations may be moved to avoid encountering reinforcing steel.

The Contractor may increase the embedment length beyond that required by the Contract Documents if approved by the Engineer. The increase shall be done at no additional cost to the State. The bottom of the hole shall be at least 40 mm from the nearest free surface of a structural element, unless otherwise shown in the contract documents.

Grout storage and handling, hole diameter, cleaning of the hole, and installation shall be in accordance with the grout manufacturer's instructions.

The anchor shall be inserted in the hole, at least, to the depth shown on the plans. After insertion of the anchor, all excess grout shall be struck-off flush with the concrete surface.

Acceptance of Anchor Installations

A number of anchors in each lot shall be randomly chosen by the Engineer for load testing. The number to be load tested in each lot shall be in accordance with Table 1. A lot size is determined by the Contractor, but must meet the following criteria:

ITEM 16586.20XXYY M - DRILLING AND GROUTING ANCHOR BOLTS AND REBARS IN CONCRETE

1. A lot size shall not exceed 600 anchors.
2. All anchors in a lot must be installed within a two-month period.
3. Any anchors installed beyond the two-month period set forth in 2. above shall be part of another lot.
4. A lot shall only include anchors grouted with a single product.
5. A lot shall only include anchors of the same type, diameter and embedment depth.

Testing of anchors in a lot shall not begin until all the anchors in the lot are installed.

Table 1 indicates for each lot size, the initial number of anchors required for testing (N1) and the number of anchors required for additional testing (N2).

Table 1

<u>LOT SIZE</u>	<u>N1</u>	<u>N2</u>
1-30	All the anchors in the lot	--
31-50	30	--
51-75	38	--
76-100	44	21
101-200	49	26
201-300	50	30
301-600	55	30

If all of the N1 anchors selected for testing pass the load test, the lot shall be accepted.

If the lot size is 75 or less and one of the N1 anchors fail the load test, all the remaining anchors in the lot shall be tested.

If the lot size is 76 or greater and an N1 anchor fails the load test, the Engineer shall immediately add the appropriate N2 number of anchors to the N1 anchors being tested. If no additional N1 and none of the N2 anchors fail the load test, the lot shall be accepted.

If any additional N1 or any of the N2 anchors fails a load test, all of the remaining anchors in the lot shall be tested.

Testing Equipment

The equipment shall consist of a load cell, jacking system, a frame to distribute the jack load, couplers to connect the jack to the anchors, and appropriate safety devices. Prior to starting the testing, the Contractor shall supply the Engineer with a certificate of calibration for the load cell performed within the previous six months by an independent testing agency.

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Supports for the frame used to distribute the jack load shall be located outside a circle centered at the anchor. The circle shall have a diameter equal to two inches plus twice the anchor embedment length, but need not exceed 24 inches. The frame and jack shall be positioned so that the load is applied along the axis of the anchor. Chains or cables shall be used to connect the various pieces of the tensioning system so that free flying projectiles will not be created by the failure of an anchor coupling or other portion of the testing system.

The test load for anchor bolts shall be 90% of the ASTM proof load, unless otherwise specified in the contract documents. When no proof load is given in the ASTM specifications for an anchor bolt steel, use the yield strength. The test load for rebars shall be 90% of the yield strength unless otherwise specified in the contract documents. Listed below are the test loads for the most commonly used anchor bolt and rebar steels, and anchor types.

TEST LOADS

ASTM A568M Property Class 8.8 ANCHOR BOLTS
(Coarse-Threaded Full Length)

ASTM A616M (or A615M) GR420 REBARS

<u>Diameter</u> (mm)	<u>Test Load</u> (kN)	<u>Size</u>	<u>Test Load</u> (kN)
13	48.49	#4	48.04
16	76.95	#5	74.29
19	113.87	#6	105.87
22	157.02	#7	144.12
25	206.4	#8	189.94
29	225.97	#9	240.20
32	286.91	#10	305.15
		#11	374.54
		#14	540.46

Anchors shall be deemed to pass if the specified test load is attained without permanently displacing the anchors. NOTE: THIS LOAD TESTING IS DESIGNED TO BE NON-DESTRUCTIVE. LOADING SHALL BE STOPPED AS SOON AS THE TEST LOAD IS REACHED.

Repairs

Concrete spalled or otherwise damaged by the load testing shall be repaired in a manner satisfactory to the Engineer. Such repair shall be done at the Contractor's expense. All anchors which fail a load test, or are otherwise damaged, shall be replaced at the Contractor's expense. All such replaced anchors shall be load tested.

METHOD OF MEASUREMENT

Measurement will be taken as the number of anchors installed as indicated in the contract documents. No payment will be made for anchors which fail load tests.

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BASIS OF PAYMENT

The price bid per each installed anchor shall include the cost of all labor, materials and equipment necessary to complete the work. The cost of the anchors will be paid for under a separate item.

Note: The manner in which the serialized portion of this specification is input as follows:

Third and Fourth digits to the right of the decimal place insert: "01" For anchor bolts
"02" For rebars

Fifth and Sixth digits to the right of the decimal place insert: Anchor Bolts: The diameter of the bolt to the nearest millimeter.
Rebars: Insert the metric bar size for the rebar.

ITEM 16586.20XXYY - DRILLING AND GROUTING ANCHOR BOLTS AND REBARS IN CONCRETE

DESCRIPTION

The work shall consist of drilling holes into existing concrete, at locations and depths shown on the plans, and grouting anchor bolts or rebars into them. Henceforth in this specification the term "anchor" shall mean either anchor bolt, or reinforcing bar. Drilling shall be done using a rotary-impact drill. If reinforcing steel is encountered it shall be cut with a core drill. The work shall also include providing load test equipment and load testing of anchors designated by the Engineer. The anchors will be paid for under another item.

MATERIALS

The Contractor shall use a grout which meets NYS Standard Specifications, Section 701-07 ANCHORING MATERIALS - CHEMICALLY CURING.

The Contractor is hereby notified that not all approved grouts have the same bond strength nor are they compatible with all concretes. Therefore, it is the Contractor's responsibility to assure the concrete-grout compatibility by pretesting a number of anchors to their test load before starting production grouting. The Contractor shall choose the number of anchors to be pretested to assure concrete-grout compatibility.

CONSTRUCTION DETAILS

Only a rotary impact drill is to be used to drill holes in concrete. If a rebar is encountered, it shall be cut with a core drill. After the rebar is cut, the remainder of the hole shall be drilled with a rotary impact drill.

Drilling shall not cause spalling, cracking or other damage to the concrete. Concrete spalled or otherwise damaged by the Contractor's operations shall be repaired in a manner satisfactory to the Engineer. Such repair shall be done at no additional cost to the State.

Drilling with a lubricant, including detergents, other than water shall not be permitted.

If approved by the Engineer, hole locations may be moved to avoid encountering reinforcing steel.

The Contractor may increase the embedment length beyond that required by the Contract Documents if approved by the Engineer. The increase shall be done at no additional cost to the State. The bottom of the hole shall be at least 1.5 inches from the nearest free surface of a structural element, unless otherwise shown in the contract documents.

Grout storage and handling, hole diameter, cleaning of the hole, and installation shall be in accordance with the grout manufacturer's instructions.

The anchor shall be inserted in the hole, at least, to the depth shown on the plans. After insertion of the anchor, all excess grout shall be struck-off flush with the concrete surface.

Acceptance of Anchor Installations

A number of anchors in each lot shall be randomly chosen by the Engineer for load testing. The number to be load tested in each lot shall be in accordance with Table 1. A lot size is determined by the Contractor, but must meet the following criteria:

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The equipment shall consist of a load cell, jacking system, a frame to distribute the jack load, couplers to connect the jack to the anchors, and appropriate safety devices. Prior to starting the testing, the Contractor shall supply the Engineer with a certificate of calibration for the load cell performed within the previous six months by an independent testing agency.

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The test load for anchor bolts shall be 90% of the ASTM proof load, unless otherwise specified in the contract documents. When no proof load is given in the ASTM specifications for an anchor bolt steel, use the yield strength. The test load for rebars shall be 90% of the yield strength unless otherwise specified in the contract documents. Listed below are the test loads for the most commonly used anchor bolt and rebar steels, and anchor types.

TEST LOADS

ASTM A449 ANCHOR BOLTS (Coarse-Threaded Full Length)

ASTM A616 (or A615) GR 60 REBARS

<u>Diameter</u> (in.)	<u>Test Load</u> (lbs.)	<u>Size</u>	<u>Test Load</u> (lbs.)
1/2	10,900	#4	10,800
5/8	17,300	#5	16,700
3/4	25,600	#6	23,800
7/8	35,300	#7	32,400
1	46,400	#8	42,700
1-1/8	50,800	#9	54,000
1-1/4	64,500	#10	68,600
		#11	84,200
		#14	121,500

Anchors shall be deemed to pass if the specified test load is attained without permanently displacing the anchors. NOTE: THIS LOAD TESTING IS DESIGNED TO BE NON-DESTRUCTIVE. LOADING SHALL BE STOPPED AS SOON AS THE TEST LOAD IS REACHED.

Repairs

Concrete spalled or otherwise damaged by the load testing shall be repaired in a manner satisfactory to the Engineer. Such repair shall be done at the Contractor's expense. All anchors which fail a load test, or are otherwise damaged, shall be replaced at the Contractor's expense. All such replaced anchors shall be load tested.

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Third and Fourth digits to the right of the decimal place insert: "01" For anchor bolts
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