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SUPERSEDED BY EI 97-007 EFFECTIVE 7/10/97

ENGINEERING INSTRUCTION

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

SUBJECT: BRIDGE DESIGN MANUAL, DESIGN CRITERIA FOR BRIDGES, SPECIFICATION FOR BRIDGE RECONSTRUCTION DRILLING AND GROUTING HIGH STRENGTH ANCHOR BOLTS

Subject Code: 727-1-586; 7.35-6

Distribution: 31 [X] Main Office 33 [X] Regions 34 [X] Special

Code: EI 84-57

Date: 12-6-84

Supersedes:

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Accompanying this Engineering Instruction is a copy of Item 15586.19 Drilling and Grouting High Strength Anchor Bolts. This item was developed especially for bridge railing retro-fit applications, but is applicable to other usages such as fascia mounted signs. This item shall be used for all railing anchor bolts installed in existing concrete, except where the depth of concrete is not sufficient to develop the strength of the anchor bolt.

Note that the only information necessary on the plans is the location and depth of embedment; hole diameter varies depending on the grout system selected by the Contractor. The Designer may indicate which coordinate(s) of a bolt pattern is important to the design to assist the Engineer-In-Charge in determining whether the bolts can be moved to avoid reinforcing steel. (e.g. The curb line to anchor bolt dimension for a railing is important, but the whole anchor bolt pattern could be moved longitudinally to avoid rebars; so long as the maximum post spacing is not exceeded or other conflict created.)

The embedment depths given in the specification are sufficient to develop the strength of ASTM A449 anchor bolts. If other anchor bolt steels are specified by the designer the embedment depths and the test load must be changed and shown on the Plans.

The table titled Theoretical Pullout Loads accompanying this Engineering Instruction can be used to determine the embedment depth for non-ASTM A449 anchor bolts. Enter the chart in the column for the anchor bolt diameter and go down until a value equal or greater than 1.25 times the yield of the anchor bolt is reached, read the embedment depth for that line. The test load should be set no higher than 90% of the yield strength of the anchor bolt.

Questions on this specification should be referred to the Structures Division, Special Design Unit at 457-2459.

Item 15586.19 -DRILLING AND GROUTING HIGH STRENGTH ANCHOR BOLTS.

Description. The work shall consist of drilling holes into existing concrete and grouting anchor bolts into them. Drilling shall be done using a rotary, rotary-impact and/or core drill. If reinforcing steel is encountered it shall be cut with a core drill. The work shall include providing load testing equipment and performing testing on anchor bolts the Engineer shall designate.

Materials. The grouting material shall be a non-metallic, non-shrink grout or polymer resin. It shall contain no metals or products that promote corrosion of steel.

When cured, the material shall have a maximum loss of 4% when tested for freeze-thaw resistance in accordance with Materials Method 215, except the material must complete 50 cycles. The cured material shall not be reactive with salt water, portland cement, or petroleum products.

The Contractor shall supply the Engineer with two copies of the manufacturers certification that the material meets the above requirements.

Testing Equipment. The equipment shall consist of a calibrated jack system, a frame to distribute the jack load, couplers to connect the jack to the anchor bolts, and safety devices. Prior to starting the testing, the Contractor shall supply the Engineer with a certificate of calibration for the jack less than 6 months old.

Supports for the frame used to distribute the jack load shall be located outside a circle centered at the anchor bolt and of a diameter equal to 2 inches plus twice the anchor bolt embedment length but need not exceed 24 inches. The frame and jack shall be positioned so that the load is applied along the centerline of the anchor bolt. Chains or cables shall be used to connect the various pieces of the tensioning system so that free projectiles will not be created by a failure of an anchor bolt anchorage, coupling or other portion of the tensioning system.

Construction Details. All equipment proposed for use shall be approved by the Engineer prior to actually performing the work.

Drilling with a lubricant will not be permitted. Water is not considered a lubricant.

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

Hole diameter shall be in strict accordance with the manufacturer's instructions.

Unless otherwise specified in the Contract Documents, the minimum depth of embedment of the anchor bolt shall be in accordance with the following:

Anchor Bolt Diameter (inches)	Embedment Length (inches)
1/2	5.5
9/16	6
5/8	6.5
3/4	8
7/8	8.5
1	10
1-1/8	12
1-1/4	15

The Contractor may increase the embedment length beyond that shown on the Plans or specified in the above table provided 1). the increase is done at no additional cost to the State and 2). the hole stops at least 2 inches from the bottom of the structural slab.

Drilling methods 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 the expense of the Contractor.

The anchor bolt shall be inserted at least the specified depth into the hole. After insertion of the bolt, all excess grout shall be struck-off flush with the concrete face. Should the grout fail to fill the hole, additional grout shall be added to the hole to allow a flush strike-off.

Testing. A portion of each lot of grouted-in anchor bolts shall be designated by the Engineer for load testing. The first lot shall consist of the first 10 grouted in anchor bolts. The remaining lots shall be defined by the Contractor subject to the following:

1. The lot size shall not exceed 600 anchor bolts.
2. A lot shall only include anchor bolts installed during a single construction season.
3. A lot shall only include anchor bolts grouted with the same grout or resin.

Unless otherwise specified in the Contract Documents, the minimum load applied during the load testing shall be in accordance with the following:

Diameter (in.)	Test Load (lbs.)
1/2	10,900
9/16	13,900
5/8	17,300
3/4	25,600
7/8	35,300
1"	46,400
1-1/8	50,800
1-1/4	64,500

Table 1 shows the lot size (column L), the initial number of anchor bolts selected for testing (column N1) and the number of anchor bolts selected for additional testing (column N2).

Table 1.

L	N1	N2
1-30	All the bolts 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 anchor bolts selected for testing pass the load test, then the lot shall be accepted.

If the lot size is 75 or less and one or more of the N1 anchor bolts fail the load test, then all the anchor bolts in the lot shall be tested.

If the lot size is 76 or greater and only 1 of the N1 anchor bolts fails the load test, the Engineer shall designate an additional N2 anchor bolts for testing. If none of the N2 anchor bolts fail the load test, the lot shall be accepted. If any of the N2 anchor bolts fails the load tests all of the anchor bolts in the lot shall be tested.

If the lot size is 76 or greater and more than one of the N1 anchor bolts fail the load testing then all the anchor bolts in the lot shall be tested.

Anchor bolts shall be deemed to pass if the specified test load is attained without permanently displacing the anchor bolts. NOTE: THIS LOAD TESTING SHOULD BE NON-DESTRUCTIVE. LOADING SHOULD BE STOPPED AS SOON AS THE MINIMUM ACCEPTABLE PULL-OUT RESISTANCE IS ATTAINED.

Repairs. 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 the expense of the Contractor. All anchor bolts which fail a load test shall be replaced at the Contractor's expense. All such replaced anchor bolts shall be tested.

Method of Measurement. Measurement will be taken as the number of anchor bolts times the linear feet of embedment specified in the Contract Documents. No measurement will be made for anchor bolts which fail load tests.

Basis of Payment. The unit price bid per linear foot shall include the cost of all labor, materials and equipment necessary to complete the work. The cost of the anchor bolts will be paid under a separate item.

THEORETICAL PULLOUT LOADS
For Anchor Bolts Embedded in 3000 psi Reinforced Concrete

Depth	Diameter of Bolt					
Inches	.625	.75	.875	1.0	1.125	1.25
3	6359					
3.5	8442					
4	10817	11110				
4.5	13485	13814				
5	16446	16811	17176			
5.5	19698	20100	20502			
6	23243	23682	24120	24559		
6.5	27081	27556	28031	28506		
7	31210	31722	32234	32745	33257	
7.5		36181	36729	37277	37825	
8		40932	41517	42101	42686	43271
8.5			46597	47218	47839	48461
9			51969	52627	53285	53943
9.5			57634	58328	59023	59717
10			63591	64322	65053	65784
10.5				70608	71375	72143
11				77186	77990	78794
11.5				84057	84898	85738
12				91220	92097	92975
12.5					99589	100503
13					107374	108324
13.5						116438
14						124843