

SUPERSEDED BY EB 15-031 EFFECTIVE 9/28/15		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 08-012
Title: ANCHORING MATERIALS - CHEMICAL CURING, NTSB SAFETY RECOMMENDATIONS			
Distribution: ☒ Manufacturers (18) ☐ Surveyors (33) ☒ Local Govt. (31) ☒ Consultants (34) ☒ Agencies (32) ☒ Contractors (39) ☐ _____ ()		Approved:  Robert L. Sack, P.E. Deputy Chief Engineer, Research 18 MAR 08 Date	

ADMINISTRATIVE INFORMATION:

- This Engineering Instruction (EI) is effective upon signature.
- This EI supersedes EI 97-007.
- The revisions issued by this EI will be incorporated into a future update of the Standard Specifications.

PURPOSE: This EI transmits safety recommendations and use limitations of adhesive anchors known as §701-07 *Anchoring Materials – Chemical Curing*. The anchoring material is used in conjunction with Standard Specification Section 586 *Miscellaneous Structural Reconstruction*, under the subsection for drilling and grouting, and a number of other special specifications. A shelf note limiting use of these materials will be inserted into all proposals. When special specifications address drilling and grouting applications that are overhead or where failure would pose significant risk to the public, such specifications will be disallowed for use until revisions are made providing alternate anchoring methods or materials.

TECHNICAL INFORMATION:

- This EI provides new guidance to design, construction, contractor, and maintenance personnel limiting the use of adhesive anchors, known specifically by the NYSDOT as §701-07 *Anchoring Materials – Chemical Curing*, for safety reasons. The policy is in accordance with the National Transportation Safety Board (NTSB) Safety recommendations limiting the use of adhesive anchors where a potential risk to the public may exist.
- In conjunction with this EI, Engineering Bulletins (EB) are being issued that provide guidance to be included in the Bridge Design Manual and the Construction Administration Manual limiting those applications where adhesive anchors can be used on Department projects.

IMPLEMENTATION:

- Beginning with projects submitted for the letting of September 4, 2008, the Design Quality Assurance Bureau (DQAB) will insert the attached special note and revised standard specification into all contract proposals.
- Ongoing construction projects and projects submitted for letting before September 4, 2008 shall incorporate the special note and revised standard specification by Order – On – Contract.

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Disapproved Specifications: Because of the potential for use of adhesive anchor materials in overhead or risk locations, the following item numbers are disapproved by this EI:

07560.04 M	Repair Ashlar Masonry – Delamination
07560.05 M	Repair Ashlar Masonry – Stone Patch
10560.80	Brick Facing
10564.96XX	Fender System Rehabilitation
586.01	Drilling and Grouting Bolts, or Reinforcing Bars
08568.0511	Steel Pedestrian Railing
11586.2001 M	Drill and Grout Anchor Bolts in Concrete
16586.20XXYY	Drilling and Grouting... In Concrete
63596.01XX	Drilling and Grouting Bolts...Emergency Standby Contract Work
63586.XXYYZZ	Drilling and Grouting... Emergency Standby Contract Work
08607.40XX	Steel Picket Fence
11607.44	Steel Picket Fence and Gates
04607.9130 M	Aesthetic Pedestrian Fence
11607.9902	Protective Screening
11607.9904	Special Protective Screening on Bridges
11615.8099	Decorative Railing
11634.9901	Tensioned Fabric Roof
08670.01	Restore Existing Light Standard Foundations

The above items, depending on details in plans, could be used in locations that are overhead or where there is potential risk to the public. Because of these possible uses these items are being disapproved. Some items may also have improper cross references or require changes in method of measurement. These items may be rewritten by those responsible for the specifications or by those wanting to incorporate a specification into a project. Revisions must address the use limitations of adhesive anchors in overhead or risk applications and provide alternate methods or materials for anchoring.

New Specifications:

586.02	Drilling and Grouting Bolts or Reinforcing Bars
586.03	Drilling and Grouting Bolts or Reinforcing Bars with Pullout Test
586.04	Drilling and Grouting Bolts, Overhead or Sustained Tension, with Pullout Test

TRANSMITTED MATERIALS: This EI transmits the shelf note to be included in all contract proposals. Further, this EI provides a revised Standard Specification Section 586, *Miscellaneous Structural Reconstruction* and supersedes EI 97-007, incorporating much of that EI into the new Section 586.

BACKGROUND: In early August of 2007, the NTSB provided recommendations for the use of adhesive anchoring systems in highway construction, after completing a thorough investigation of the July 10, 2006 ceiling collapse in a portion of the Interstate 90 connector tunnel in Boston, Massachusetts. The NTSB strongly recommends that the FHWA and each State Department of Transportation prohibit the use of adhesive anchors in applications where failure could result in risk to the public. More specifically the directives of the NTSB recommend:

- Prohibit the use of adhesive anchors in sustained tensile-load overhead applications where failure would result in risk to the public.

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- Review the use of adhesive anchors and identify sites where failure under sustained tensile load could result in risk to the public, provide inspection of the sites, and establish a repair program to ensure that failures do not occur.

The limitations placed on the use of adhesive anchors by this EI address the NTSB recommendations and are the direct result of FHWA directives issued to assure the safety of the public. Historically, the Department has extensive experience with mechanical anchors, cement based grouted anchors, and adhesive anchors. Such experience has been considered in developing the use limitations of adhesive anchors in this EI.

Experience with mechanical anchors many years ago was less than desirable. For applications where there was cyclic loading, several types of expansion anchors performed poorly over time. As such, the Department restricted their use. As a result, the Department made extensive use of cement based grouts and chemically curing grouts as alternative anchor systems. Problems encountered with some of these materials related to anchor design, material properties, construction procedures, and quality control. As experience was gained, the Department developed better design standards, materials and construction specifications, tightened quality assurance procedures, and developed a proof testing quality control procedure. Chemical curing anchor materials became the predominate product of use because of construction handling and placing capabilities.

Performance of a number of applications have been monitored, specifically on bridges through biennial inspections, or had long term testing performed, such as for rock bolt installations. To date the Department has not experienced any failures of adhesive anchors. Because of the Department's experience, use of adhesive anchors in non-risk applications will continue to be allowed. The Department will also continue to monitor many applications, and has commenced an evaluation of various adhesive anchor uses to determine the effectiveness of these products in Department applications. Future design guidance, construction guidance, and specifications will be modified as appropriate based on the outcome of the evaluation.

This EI issues a special note limiting the use of adhesive anchors, known specifically by the NYSDOT as §701-07 *Anchoring Materials – Chemical Curing*. Further, a revised Standard Specification Section 586, *Miscellaneous Structural Reconstruction*, is issued in this EI. Use of chemical curing anchoring materials will not be allowed in any overhead application.

At the national level, research to develop long term creep test methods and material performance limits has commenced. When the national level testing is complete, the Department will revise specifications accordingly.

REFERENCES: NTSB Safety Recommendations H-07-23 and H-07-24 with supporting information is available at www.nts.gov/publictn/2007/HAR0702.pdf . Additionally, FHWA has issued a Technical Advisory, Use and Inspection of Adhesive Anchors in Federal-Aid Projects available at www.fhwa.dot.gov/legregs/directives/techadvs/t514026.htm .

CONTACT: Direct questions regarding this EI to Don Streeter of the Materials Bureau via email at dstreeter@dot.state.ny.us or at (518) 457-4593. Questions related specifically to Standard Specification 586, *Miscellaneous Structural Reconstruction*, should be directed to Duane Carpenter of the Office of Structures via email at dcarpenter@dot.state.ny.us or at 518 457-5715.

SPECIAL NOTE
ANCHORING MATERIALS - CHEMICAL CURING

SPECIAL NOTE

Due to safety concerns, the use of §701-07 *Anchoring Materials – Chemical Curing*, will not be allowed in any overhead applications or where sustained tensile loads will exist. This requirement includes but is not limited to direct overhead installations such as utilities to undersides of bridge decks and overhead protective screening.

When such work is required, alternative anchoring methods or materials like mechanical anchors or cementitious grouting operations, must be used in these locations. Use of alternate materials or methods not previously approved shall require approval of the Deputy Chief Engineer Structures (DCES).

Further, use of §701-07 *Anchoring Materials – Chemical Curing* will not be allowed in any horizontal or vertical applications where failure would result in risk or injury to the public. Applications where only cementitious grouts shall be required include but are not limited to decorative railings, pedestrian fence, and screening. Bridge railing installations shall only use §701-05 *Concrete Grout Materials* as presently required by specifications. Substitution of §701-07 *Anchoring Materials – Chemical Curing* shall not be allowed for bridge railing installations.

Use of §701-07 *Anchoring Materials – Chemical Curing*, may be allowed for temporary applications, and when specified, shall be designed and stamped by a PE. Temporary items anchored using §701-07 *Anchoring Materials – Chemical Curing* shall be rendered inoperable upon completion of their use on a project.

ANCHORING MATERIALS - CHEMICAL CURING

Make the following changes to the Standard Specifications of May 4, 2006:

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delete Section 586 in its entirety and *replace* it with the following:

SECTION 586 - MISCELLANEOUS STRUCTURAL RECONSTRUCTION

586-1 DESCRIPTION. The work of this section shall consist of the following:

- Drilling and Grouting Bolts, or Reinforcing Bars.
- Removal of Rivets-Replacement with High Strength Bolts.
- Field Drill Holes in Existing Structural Steel.

586-1.01 Drilling and Grouting Bolts, or Reinforcing Bars. For the purposes of this section the terms bolts and reinforcing bars are identical.

586-1.02 Field Drill Holes in Existing Structural Steel. Existing structural steel is that structural steel in service prior to the beginning of construction.

586-2 MATERIALS

586-2.01 Drilling and Grouting Bolts. Grout material used in overhead applications, or where a sustained tensile load will exist, shall conform to §701-05 *Concrete Grouting Material*. Grout used in other applications shall conform to §701-07 *Anchoring Materials - Chemically Curing*.

586-2.02 Removal of Rivets - Replacement with High Strength Bolts. High strength bolts, nuts and washers shall meet the requirements of §715-14 *High Strength Bolts, Nuts and Washers*. If paint color is not specified, the color selected shall match the existing paint. Paint shall be selected from the Department's Approved List for Structural Steel Paint - Class 2.

586-3 CONSTRUCTION DETAILS

586-3.01 Drilling and Grouting Bolts

A. All holes shall be drilled by means of a rotary impact drill. If reinforcing steel is encountered, the reinforcing steel shall be cut and removed by means of a core drill. The remainder of the drilling shall be done with the rotary impact drill.

B. Drilling with a lubricant will not be permitted. Water is not considered a lubricant. Drilling methods shall not cause spalling, or other damage to concrete. Concrete spalled, or otherwise damaged by the Contractor's operations shall be repaired at no additional cost to the State.

C. Holes shall be surface dry and shall have had all foreign and loose material removed immediately prior to grout placement.

D. Grout shall be stored, mixed, and placed in strict accordance with the manufacturer's instructions, unless modified here, or elsewhere, in the contract documents. No grout shall be placed at a temperature below that recommended by the grout manufacturer.

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E. Prior to bolt placement in the grouted hole, all material which might interfere with bond between the bolt and the grout shall have been removed. This includes, but is not limited to: moisture, grease, dirt, mill scale and rust. Rust which cannot be removed even by vigorous scrubbing with a wire brush is considered firmly bonded and may remain. The hole diameter shall be in accordance with the grout manufacturer's recommendation. The length of any plastic sleeve used as an aid to grout placement shall not be included in the length of the bolt hole. The bolts shall be inserted full depth into the hole and shall be manipulated and rotated to ensure complete coverage by the grout. After insertion of the bolt, all excess grout shall be struck off flush with the concrete face. Care shall be taken to prevent grout from running out of the drilled hole. Should the grout fail to fill the hole after bolt insertion, additional grout shall be added to the hole to allow a flush strike-off.

F. If the bolt is inserted in a hole with an axis that is predominantly horizontal, care shall be taken to prevent grout from running down the face of the concrete.

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

H. The Contractor may increase the embedment length beyond that required by the contract documents if approved by the Engineer, 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.

586-3.02 Pull-Out Testing

A. Testing. Table 1 gives the number of anchors (N1) to be tested for any lot size. The Engineer will randomly choose the anchors to be tested. Testing of anchors in a lot shall not begin until all the anchors in the lot are installed. If any (N1) anchors fail, N2 indicates the number of additional anchors that must be tested. If only one anchor fails, the lot will be accepted. If a second anchor fails, all remaining anchors must be tested.

A lot size is determined by the Contractor, but must meet the following criteria:

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.

Table 586-1 NUMBER OF ANCHORS TO BE TESTED		
LOT SIZE	N1	N2
1-30	All the anchors in the lot	-
31-50	30	All remaining anchors
51-75	38	All remaining anchors
76-100	44	21
101-200	49	26
201-300	50	30
301-600	55	30

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B. 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. A calibrated pressure gauge with hydraulic ram is equivalent to a load cell. 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. 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 50 mm plus twice the anchor embedment length, but need not exceed 600 mm. 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.

C. Test Load. 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 anchor bolt steel, use the yield strength. The test load for reinforcement 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 bolts and rebar steels, and anchor types.

Table 586-2 TEST LOADS			
ASTM A568 Property Class 8.8 Anchor Bolts (Coarse-Threaded Full Length)		ASTM A615M GR 420 Reinforcement Bars	
Diameter (mm)	Test Load (kN)	Size	Test Load (kN)
13	48	13	48
16	77	16	74
19	114	19	106
22	157	22	144
25	206	25	190
29	226	29	240
32	287	32	305
		36	375
		43	540

Anchors shall be deemed to pass if the specified test load is attained without permanently displacing the anchors. Concrete spalled or otherwise damaged by the load testing shall be repaired. Such repair shall be done at no additional cost to the State. All anchors which fail a load test, or are otherwise damaged, shall be replaced at no additional cost to the State. All such replaced anchors shall be load tested.

NOTE: THIS LOAD TESTING IS DESIGNED TO BE NON-DESTRUCTIVE. LOADING SHALL BE STOPPED AS SOON AS THE TEST LOAD IS REACHED.

586-3.03 Removal of Rivets-Replacement with High Strength Bolts

A. Paint Removal. If the steel is painted, then prior to the beginning of any other work operations, the paint shall be removed for a minimum distance of 100 mm on each side of the centerline of work location. The paint removal work shall be done in accordance with the requirements of Section 574, *Structural Steel Painting: Localized*.

B. Unless otherwise noted in the contract documents, all bolts shall be the same diameter as the

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rivets they replace.

C. Rivets shall be removed by one of the following methods:

1. Shear rivet head using a pneumatic rivet breaker (helldog), and drive out rivet shank with a pneumatic punch.
2. Flame cut rivet head 2 mm above the base metal using a rivet scarfing tip, and drive out shank using a pneumatic punch. If punching will damage the base metal, the shank shall be removed by drilling.

D. High strength bolts shall be installed after the nicks, burrs and foreign substances that might interfere with seating of the bolt head and nut washers are removed. Light grinding may be required.

E. Installation and inspection of high strength bolts shall be done in accordance with the New York State Steel Construction Manual requirements.

F. If it becomes necessary to disconnect, or adjust, steel remaining as part of the structure to complete the work the Contractor shall obtain the Engineer's approval prior to performing disconnections or adjustments.

G. If the bolt will not fit the rivet hole, the hole may be reamed sufficiently to accommodate the bolt.

H. If the contract does not include an item(s) for cleaning, priming and painting of structural steel, cleaning and painting of the bolt and immediate surrounding area shall be done as part of this work. Cleaning and painting shall be done in accordance with the requirements of Section 574, *Structural Steel Painting: Localized*. All steel exposed by the cleaning operations shall be painted. However, at least 50 mm in every direction, measured from the washer's edge, shall be painted.

586-3.04 Field Drill Holes in Existing Structural Steel

- A.** The requirements of §586-3.03A *Paint Removal* shall apply.
- B.** The required hole diameter will be indicated on the contract documents.
- C.** No flame cutting, or flame drilling will be permitted.
- D.** All damage to existing steel shall be repaired by the Contractor, at no additional cost to the State.

586-4 METHOD OF MEASUREMENT

586-4.01 Drilling and Grouting Bolts. The quantity to be measured for payment will be the number of holes into which grout and bolts have been inserted.

586-4.02 Removal of Rivets - Replacement with High Strength Bolts. The quantity to be measured for payment will be the number of high strength bolts installed.

586-4.03 Field Drill Holes in Existing Structural Steel. The quantity to be measured for payment will be each hole drilled.

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586-5 BASIS OF PAYMENT

586-5.01 Drilling and Grouting Bolts

- A.** The unit price bid per hole shall include the cost of all labor, materials, and equipment necessary to complete the work.
- B.** Payment will not be made for holes which do not contain both grout and bolts.
- C.** The cost of the bolts will be paid for under a separate, appropriate item.

586-5.02 Removal of Rivets - Replacement with High Strength Bolts

- A.** The unit price bid for each installed bolt shall include the cost of all labor, material and equipment necessary to complete the work including paint removal and when appropriate painting.
- B.** Payment will be made for each installed bolt regardless of whether or not a rivet had been removed from the location in question.

586-5.03 Field Drill Holes in Existing Steel

- A.** The unit price bid for each hole drilled shall include the cost of all labor, equipment and materials necessary to complete the work, including paint removal when required.
- B.** No extra compensation will be paid for holes drilled through different thicknesses, or through different numbers of plates.

Payment will be made under:

Item No.	Item	Pay Unit
586.02	Drilling and Grouting Bolts or Reinforcing Bars	Each
586.03	Drilling and Grouting Bolts or Reinforcing Bars with Pullout Test	Each
586.04	Drilling and Grouting Bolts, Overhead or Sustained Tension, with Pullout Test	Each
586.05	Removal of Rivets-Replacement with High Strength Bolts	Each
586.10	Field Drill Holes in Existing Structural Steel	Each