Using Bonding Enamel-Coated Steel Fixtures to Produce More Durable Brick/Masonry Structures

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### Using Bonding Enamel-Coated Steel Fixtures to Produce More Durable Brick/Masonry Structures

**Abstract**

2010 U.S. Army Corrosion Summit, Huntsville, AL, 9-11 Feb

**Subject Terms**

- unclassified
- unclassified
- unclassified

**Security Classification of:**

- a. Report: unclassified
- b. Abstract: unclassified
- c. This Page: unclassified

**Limitation of Abstract:**

- Same as Report (SAR)

**Number of Pages:**

- 23

**DISTRIBUTION/AVAILABILITY STATEMENT**

Approved for public release; distribution unlimited
Topics to Cover

- Problems with Masonry Ties
- Properties of Bonding Coatings
- Effects of Corrosion and Failure
- Types of Ties and Installation
- Standardization
- Target Test Site
- Test Program and Metrics
- Summary and Questions
Problem

- Masonry/brick construction involves a wide variety of metal fittings that brace the units in the wall
- Fittings are critical to the structural integrity of the wall
- Metal fitting are typically located where they can quickly corrode
Hollow Core Walls are Ideal Spaces for Corrosion to Occur

- Bricks allow moisture to pass through
- Moisture barriers are typically on the inner wall
- The cavity is typically very moist for long periods of times

Corroded strap-type wall tie
Ties Join Courses and Lateral Units

- Ties hold brick veneer to a stud wall or a masonry block wall
- Lateral layers of block are held together with continuous truss ties
- There are a wide variety of ties designed to meet specific construction needs
Bonding Enamel Coatings for Masonry Ties

- Standard alkali-resistant glass enamel is fired onto the steel fittings
- A layer of portland cement is added to the heat softened glass enamel
- Finished reinforcement is corrosion resistant and has 3 to 4 times stronger bond to the mortar
- No reduction of the strength of the wall at the point of mortar-to-tie contact
Bonding Enamel Increases Peak Pull-out Stress

- Enamel on a strap can increase the adhesion of the surface of the metal to the surrounding mortar.
- Initial tests with enameled metal straps cracked all the test cylinders and straps would not pull out.
New Strong Durable Ties

- Work done to date with steel pins has shown that bond strength can be three to four times more can uncoated steel
- Intact enamel can make metal very corrosion resistant

Cement fused to the glass enamel makes strong bond to surrounding mortar

Steel is protected from corrosion as long as glass enamel is intact
Corrosion of Ties Breaks Bricks and Mortar

- Corrosion increases the volume of the iron that reacts by 600% and cracks the mortar
- Porosity of bricks hold moisture for long periods of times
- The thick layer of concrete (mortar) that would offer protection to steel reinforcement is not present
Modes of Failure for Wall Ties

- Ties can fail by corroding though and physically breaking
- Corrosion in mortar joints can crack the mortar and break the tie-to-mortar bond
- Stress problems in walls often related to settling problems, seismic events and pressure from wind and rain
Types of Masonry Ties

- Rectangular Tie
- Z-tie
- Corrugated Tie
Installation of Ties in Solid and Cavity Walls

Solid Masonry Wall  Hollow Masonry Wall  Wood Stud Backing
Ladder Type Wall Ties

- Ladder-Type
- Tab-Type
- Truss-Type
- Ladder-Type w/Reinforcement
Adjustable Masonry Ties

Set-ups for Ties

Details for Adjustable Ties
Ties are All Standardized as to Materials Specifications

<table>
<thead>
<tr>
<th>Tie System</th>
<th>Minimum Specified Dimension¹</th>
<th>Wire Size</th>
<th>Gage</th>
<th>Dimension, in. (mm)</th>
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<tbody>
<tr>
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<tr>
<td>Unit Ties</td>
<td>Rectangular and &quot;Z&quot;</td>
<td>WW1.7</td>
<td>9</td>
<td>0.15 (3.8)</td>
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<tr>
<td></td>
<td>WW2.8</td>
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<td></td>
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<tr>
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<td>22</td>
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<td>0.03 (0.8)</td>
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<td>Corrugated</td>
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<td>Ladder and Truss Type and Tabs</td>
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<td>3/16 (4.8)</td>
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<td>Joint Reinforcement, Standard and Adjustable</td>
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<td>(pintle legs min. WW2.8)</td>
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<tr>
<td></td>
<td>Dovetail/ Channel Slot Wire</td>
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<td>(pintle legs min. WW2.8)</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>Slotted Plate Wire</td>
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<td>Slotted Plate Backer Plate</td>
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<td>0.08 (2.0)</td>
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</table>

22-gage

Corrugated Type
### Specifications for Ties

<table>
<thead>
<tr>
<th>Wall Type</th>
<th>Tie System and Material</th>
<th>Maximum Cavity Width, in. (mm)</th>
<th>Maximum Area Per Tie, ft² (m²)</th>
<th>Maximum Vertical Spacing, in. (mm)</th>
<th>Maximum Horizontal Spacing, in. (mm)</th>
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<tbody>
<tr>
<td>Standard Joint Reinforcement</td>
<td>Unit Tie W1.7 W2.8</td>
<td>4.5 (114)</td>
<td>2.67 (0.25)</td>
<td>24 (610)</td>
<td>36 (914)</td>
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<td></td>
<td>Standard Joint</td>
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<td>24 (610)</td>
<td>16 (406)</td>
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<tr>
<td></td>
<td>Adj. Joint Double</td>
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<td>16 (406)</td>
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<td>Adj. Joint</td>
<td>4.5 (114)</td>
<td>1.77 (0.16)</td>
<td>16 (406)</td>
<td>16 (406)</td>
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<tr>
<td></td>
<td>Corrugated</td>
<td>1 (25)</td>
<td>2.67 (0.25)</td>
<td>18 (457)</td>
<td>32 (813)</td>
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<tr>
<td>Brick Veneer/Wood Stud</td>
<td>Other Than Corrugated</td>
<td>4.5 (114)</td>
<td>2.67 (0.25)</td>
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<td>32 (813)</td>
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<td>Adj. 2 piece W1.7</td>
<td>4.5 (114)</td>
<td>3.60 (0.33)</td>
<td>18 (457)</td>
<td>32 (813)</td>
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<td>Brick Veneer/Steel Stud</td>
<td>Adj. Unit Veneer Ties</td>
<td>4.5 (114)</td>
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<td>32 (813)</td>
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<tr>
<td></td>
<td>(2 in. (50 mm) recommended)</td>
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<td>(2.0 ft² (0.18 m²) recommended)</td>
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<td>Brick Veneer/Concrete or CMU Backing</td>
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<td>Multi-Wythe Masonry Composite</td>
<td>Joint reinforcement W1.7 W2.8</td>
<td>No Cavity</td>
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<td>24 (610)</td>
<td>36 (914)</td>
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</tbody>
</table>

- **Standard joint reinforcement**
- **16 in. horizontally**
- **24 in. vertically**

This is one tie for each 2.67 sq. ft.

A 30 ft. by 10 ft. wall would require 113+ ties.
Target Test Site

• Ft. Stewart, GA
• Southern—21 deg N latitude
• Average annual rainfall = 48.3 in.
• Max rainfall (July), average = 8.9 in.
• Average high monthly temperature = 93 deg F
• Elevation = 33 ft. above MSL
• In hurricane hazard area
• 30 miles from coast
Proposed Test Program for Bonding Enamel Ties

- Optical monitoring to detect corrosion of ties in a cavity wall
- Electrical corrosion detection systems
Standard Optical Inspection Technology to Determine Condition of Wall Ties

Locate the Metal Ties
Drill View Port
Fiber-optical Inspection
Evaluate Image

Ports can be installed as the wall is assembled
Progress of corrosion can be documented with series of photos
Electrical Corrosion Monitoring

- Half-cell corrosion potential method - accurate field potential measurements aid in detecting active corrosion
- Electrical corrosion monitor leads installed during construction
Summary

- Project will demonstrate new corrosion-resistant masonry wall ties
- Corrosion of wall ties can cause damage to masonry construction
- Proposed test site has serious wind problems
- Result of demonstration will be stronger, more durable masonry construction that can be used DoD-wide
ACKNOWLEDGEMENTS

The authors wish to recognize the Sponsors of the DoD Corrosion Prevention and Control Program:

1. Office of Under Secretary of Defense, Office of Corrosion Policy and Oversight (Director, Mr. Dan Dunmire).

2. Deputy Assistant Secretary of the Army Acquisition Policy and Logistics (Army Corrosion Control Prevention Executive, Mr. Wimpy D. Pybus).

3. Assistant Chief of Staff for Installation Management (Mr. David Purcell).


F10AR12 – Use of Corrosion-Resistant Bonding Enamel-Coated Steel Fixtures in Masonry Wall Construction
QUESTIONS