Boman Kemp Letter

QualCorr Engineering Report

Prior to backfill and well
Installation testing

Metallic Bond/Corrosion Cell

BOMAN KEMP BASEMENT WINDOW SYSTEMS

Boman Kemp Companies
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Basement Egress Windows Made Easy!
www.boman-Kemp.com

August, 2005

Subject: Important Corrosion Advisory for Easy-Well/Easy-Buck Installer

Dear Contractor,

Boman Kemp strives to provide our customers with quality products at affordable prices and, when necessary, offer important installation instructions to help ensure our products continue to perform as designed.

We are aware that a small number of window wells have shown signs of premature corrosion. After investigating this matter, we have discovered a common theme shared by window wells exhibiting these signs and are pleased to provide a simple solution to mitigate this issue.

It is important to understand that a corrosion cell requires four (4) basic elements:

- Anode (Window Well)
- Cathode(Home's ground)
- Electrolyte (Soil)
- Metallic path connecting the anode to the cathode

Removing at least one of these elements can stop the corrosion cell. When considering the four elements above, one can conclude that the most sensible element to eliminate is the metallic path between the anode (window well) and the cathode (foundation rebar.) This metallic path originates when the following conditions occur during installation:

- **Rebar in the foundation comes in contact with the Easy-Buck**
- **Fasteners used for wall mounted Easy-Wells comes in contact with foundation rebar**

Boman Kemp recommends that both foundation contractors and window well installers ensure that the bucks or wells do not come in contact with any rebar within the foundation or any other potential metallic path to ground.

We urge you to consider this situation when installing our Easy-Bucks and Easy-Wells so as to provide our clients with long-lasting products they expect.

Feel free to call us with any questions or concerns you may have or for more specific information on how to avoid this situation.

Sincerely,
Jeff Kemp

CORROSION STUDY OF BOMAN-KEMP

'EASY WELLS'

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GENERAL INFORMATION

QualCorr Engineering Corporation ("QualCorr Engineering") was contracted by Boman-Kemp to determine why one galvanized steel basement window well would show signs of accelerated, premature corrosion and an adjacent, identical window well installed within the same soil type would show no signs of corrosion. The particular window well in question is the Boman-Kemp 'Easy-Well' which is designed to bolt directly to the Boman Kemp Easy-Buck or can be bolted to the wall during basement remodeling. The Boman-Kemp easy well is made of galvanized carbon steel.

CRITERIA AND PROCEDURES

QualCorr Engineering used the criteria for corrosion protection established by the National Association of Corrosion Engineers (NACE) Standard RP-0169-2002 to determine whether the given window well was adequately protected from corrosion.

All earth-to-structure voltage potential data were measured and recorded using a Miller, Model LC4, high impedance digital voltmeter. These voltage potentials are referenced to the criteria for cathodic protection as established by the National Association of Corrosion Engineers standard RP0169-92, Section 6, Subsection 6.3.1 paragraph 1.

The criteria used to determine protection of the carbon steel window wells is satisfied by obtaining voltage potential readings of –0.85 volts, or more negative, when measured across the structure and a saturated copper / copper sulfate electrode.

DISCUSSION OF DATA

A. BACKGROUND

It is the understanding of QualCorr Engineering that Boman-Kemp has been experiencing this particular corrosion problem for several years however it has become much more frequent in recent months and especially when installed within clayey soils around newer homes. Boman-Kemp advised QualCorr Engineering that the window wells are all made by the same manufacturing company and adhere to the identical tolerances and guidelines throughout the manufacturing process. Furthermore, the window well installation procedures have remained consistent and the materials used to complete each installation have not varied.

B. GENERAL OVERVIEW

QualCorr Engineering met representatives from Boman-Kemp at a residential home site in Parker, CO on August 24th, 2005 where the easy wells had been installed. This particular home had two window wells that required replacement due to premature corrosion of the well and identical wells that showed little to no signs of corrosion. QualCorr Engineering was able to complete testing on an existing window well experiencing the types corrosion problems in question and on an adjacent window well that showed no signs of corrosion problems. QualCorr Engineering completed testing which included:

- Radio frequency electrical continuity
- Earth-to-structure voltage potential
- Soil resitivity and visual assessment
- Backfill content
- Surface coating inspection
- Electrical grounding

Upon completion of these tests, QualCorr Engineering concluded that the corrosion problem was likely due to electrical continuity between the galvanized steel window well and the home's electrical ground. To prove this hypothesis QualCorr Engineering requested that Boman-Kemp complete an experiment which involved slowly uninstalling an affected window well while observing the voltage potential of the window well. The hypothesis would be proven if the window well began with a voltage potential of ± 400mV and slowly began dropping as the backfill was removed. Once enough backfill was excavated so as to allow the entire window well to be removed from the home, the voltage potential of the window well should suddenly jump to ±900mV upon breaking the electrical continuity. The electrical continuity would be broken through the removal of any given metallic anchor point or through the direct contact with the metallic window frame. Either of these metallic paths could be electrically continuous with the rebar, conduit, water pipe or other grounded infrastructure within the home.

After completing this experiment this exact scenario played out thereby proving the theory that the window well was part of a 'dissimilar metal' galvanic corrosion cell.

A galvanic corrosion cell is an electrochemical cell that converts chemical energy into electrical energy. This is a cell in which chemical reactions occur spontaneously at the electrodes when they are connected through an external circuit, producing an electrical current. E.g., in a fuel cell hydrogen is oxidized at the anode by transferring electrons to the anode and the oxygen is reduced at the cathode by accepting electrons from the cathode. During this process the electrons are carried from the anode to the cathode through an outside electrical circuit where the electrical current can drive a motor, light a light bulb, etc. In contrast, in an electrolytic cell electrical power must be supplied to force the non-spontaneous reverse reaction, the electrolysis of water. Of course, this particular situation produces a much smaller amount of current flow.

RECOMMENDATIONS

Essentially, when the galvanized steel window well is electrically continuous with the home's ground an unintended corrosion cell is formed whereby the galvanization designed to provide only the protective current needed to protect the exposed steel due to the inevitable, small holidays in the window's coating from corrosion. In short, the galvanization of the window well is no longer being asked to protect only the well itself from corrosion but to protect all of the exposed copper and steel throughout the site sharing the same electrolyte.

A corrosion cell requires four (4) basic elements: an anode, a cathode, electrolyte and a metallic path connecting the anode to the cathode. In this case, the anode is the window well, the cathode is the home's ground, the electrolyte is the soil surrounding the home and window well and the metallic path is the window anchor point or casing. The corrosion cell can only be stopped by removing one of these elements and when considering the four elements one can conclude that the most sensible element to eliminate is the metallic path.

QualCorr Engineering recommends that the electrical continuity between the window well and the home's ground be eliminated by completing one or more of the following:

- Placement of an electrically insulative diaphragm between the window well and the metallic window casing (Easy Buck)
- Use of non-conductive anchors
- Pre-designed rebar placement that ensures rebar isolation from window well
- Electrical continuity testing after installation of window well

QualCorr Engineering appreciates the opportunity to be of assistance to Boman & Kemp. Please do not hesitate to call with questions or comments regarding this report or any other corrosion protection concerns you may have.

Sincerely,

Matt Van Auken, P.E.

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August 17, 2006

Dave Boydston
Boman-Kemp Window Systems
2393 S. 1900 West
Ogden, Utah 84409

Dear Mr. Boydston:

Thank you for the opportunity to be of assistance regarding the on-site window well investigation performed on Wednesday, August 9th, 2006 at the Chatfield Farms development. I enjoyed meeting you and working to develop a test that will effectively determine if your window wells are protected from corrosion.

Per our conversation, it is necessary to devise a simple test to determine if there is continuity between the structural rebar in the concrete walls and the basement window well. The test must be capable of being performed prior to well backfill to ensure that all window wells are isolated or, if not isolated, corrected.

Based on these requirements, Qualcorr Engineering would recommend that a fixed cell continuity test be implemented. The fixed cell continuity test is performed as follows:

A reference electrode is placed in near proximity to the UFER ground, which is tied directly to the rebar rack. With the negative lead of the multi-meter attached to the reference electrode, the positive lead is attached to the UFER ground. A voltage potential reading is taken between the structure and electrolyte. With the reference electrode in the same position, extend the positive lead to each of the window well enclosures on the home. If any of the readings are within ± 10mV of the UFER potential, it can be assumed that the window well assembly and the rebar rack are electrically continuous.

In addition to the fixed cell continuity test, I would recommend that a structure-to-soil potential test be taken upon completion of the wall backfill. With this test, readings should be more negative than -700 mV to indicate a protected structure. Readings lower than this level would indicate that there is an abnormality with either the window well or there is another metal in contact with the window system. Possibilities would include rebar, copper pipe, electrical conduit or other metal in the backfill in contact with the structure, electrical or plumbing components in contact with the well, or another type of metallic contact with the window assembly. Additionally, the galvanized coating should be inspected to determine if there are imperfections that would contribute to the low readings.

If you would like us to either perform this testing, provide a demonstration, or further assist in your investigations, please contact us to discuss your specific needs. Again, thank you for the opportunity to be of assistance with this issue. If you have any further questions, please contact me via telephone or e-mail.

Sincerely,

Chris Jennings
Qualcorr Engineering

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August, 2007

Subject: Window Well Corrosion Information for 'Easy Well' Homeowners

Dear Homeowner:

Congratulations! Your new home is equipped with Boman-Kemp 'Easy-Well' window well system that has been developed and refined with you in mind. Boman-Kemp strives to provide clients with quality products at an affordable price and, when necessary, offer important instructions to help ensure the window wells continue to exceed expectations.

It has come to our attention that a small number of window wells have shown signs of premature corrosion. After investigating this matter we have discovered a common theme shared by window wells exhibiting these signs and are pleased to provide an explanation of the situation.

Metals are consistently used for structural applications because of their unique combination of strength, rigidity, ductility, and formability. Most commonly used metals form very thermodynamically stable oxides, and therefore 'prefer' to exist as oxides, which are brittle and undesirable for structural applications. A significant amount of money is invested in turning oxides (ores) into useable metal. However, the metals that are produced are metastable and are thermodynamically driven to oxidize – metals start as dirt and try to be dirt. Corrosion is essentially the electrochemical oxidation of metallic species to their 'natural' state.

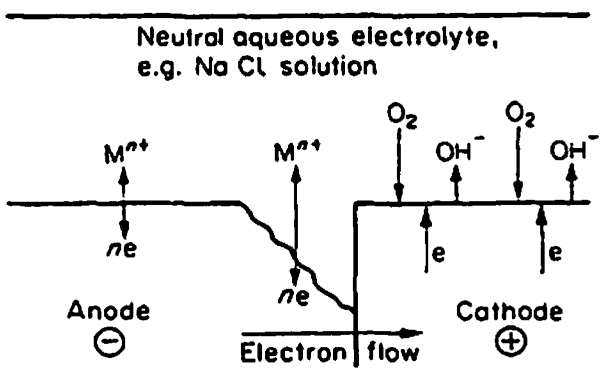

Figure 1: Basic Corrosion Cell

As shown in figure 1, in order for corrosion to occur, there must be a complete electrical circuit which includes:

1. An Anode (where oxidation is taking place and electrons are being supplied)
2. A Cathode (where reduction is taking place and electrons are being consumed)

3. Electrical contact between the Anode and Cathode
4. A conductive electrolyte that completes the circuit

Corrosion of steel is essentially the oxidation of iron to form iron oxide (commonly called rust or scale). Since there is a current associated with each pair of corrosion reactions, a series of electrical potentials (voltages), which are commonly known as the Galvanic series, are established between different metals. Galvanic potentials establish the thermodynamic 'driving force' for the oxidation reactions which drive corrosion.

When all four of these elements are present, a voltage differential is generated between the two connected metals (home's ground and the window well). The more active metal, or more anodic metal, becomes the anode of the corrosion cell, while the more noble metal becomes the cathode of the corrosion cell, causing corrosion to occur at the anode (window well).

In order to prevent this corrosion, it is necessary to ensure that the window well components are not in contact with any steel in the basement walls. Boman-Kemp has educated installers on the corrosion issue as well as procedures to use to ensure that the window buck is not in contact with the cathode. However, even with all necessary precautions, unforeseen metal within the concrete foundation or any other potential metallic path to ground can still become electrically continuous with the window well (see attached drawing).

Should the window well be determined to be in contact with an external metal, the corrosion cell is negated by removing at least one of these elements of the corrosion cell. In this case, an electrically insulated diaphragm is installed between the window well and the metallic window casing (Easy Buck). When considering the four elements above one can conclude that the most sensible element to eliminate is the metallic path between the anode and the cathode. This metallic path originates during installation and is therefore removed to break the corrosion cell.

With the metallic bond between the structure and the window well broken, the factory applied galvanizing or a field installed liner should provide sufficient corrosion protection. Localized corrosion cells may still be present on the window well, but the factory applied galvanizing or field installed coating should provide adequate corrosion protection for these local cells. Further accelerated degradation of the window well should not occur.

Feel free to call us with any questions or concerns you may have related to this situation.

Regards,

Chris Jennings
QualCorr Engineering