Inspection report 19-047

Written on behalf of MG Duff Limited

Inspection Report

This report concerns the evaluation of the surface-condition of the steel beams inside the outer walls of the building which is situated at no. 80 The Strand London after they have been treated.
The beams will have to be correctly prepared on their surfaces in order to be coated with the film-galvanising system Zinga.

Personnel Present		
Name	**Title**	**Company**
Norbert Auba	Project Engineer	Stonewest Ltd
Rick Simpson	Senior Corrosion Consultant	Zingametall bvba
Two others	Site operatives	Stonewest Ltd

9th January 2019

Inspection report 19-047

Customer address:

Stonewest Ltd
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London.
SE19 3RW

Date: 30-09-18	Your ref: Norbert Rauba	Inspection date: 08-01-19	Account no: N/A	Ref: 19-047

INSPECTION REPORT

Inspection aims:

The inspection was to verify that the surface-treatment techniques being used by the contractors "Stonewest Ltd" will provide enough surface-roughness on the steel beams being treated, and the anchor-pattern would be sufficient in order to obtain the optimum adhesion-values for the application of the film-galvanising system "Zinga".

As is the case with hot-dip galvanising, the Zinga film-galvanising layer must also be well bonded onto the steel surface in order for it to generate the required 1100 mV protective voltage and provide the optimised cathodic-protection to the steel's surface as designed for.

Methodology (repeated for clarity)

1. After the surface of a steel beam has been prepared by the usual compressed-air blast-cleaning method, according to the standard: ISO 8501-1, it is a straightforward operation to measure and record the surface-profile readings that have been obtained, and these are given an Rz value, which is the nominal value (in microns) of all the readings taken on any particular surface. An Elcometer 224 or other standard type of needle-gauge is used.

2. Where blast-cleaning is done as per clause (1) above, this will automatically produce an Ra value, which is the arithmetic average of the absolute values of all profile-height deviations as measured from the median-line, as measured at the mid-point between the average blast-peaks and the bottom of the 'valleys', according to the ISO 8503-2 standard. Between each blast-peak there are normally several minor peaks, and these are the ones that form the Ra roughness factor.

3. Needle-gunning will usually provide a measurable surface-profile or roughness on a smooth surface according to SSPC-SP 11, but no readings can be taken where old and pitted steel has been treated. Due to the age and pitted surface-condition of the beams in this building, it will not be possible to obtain any accurate roughness-values using either a needle-type blast-profile gauge or Testex Tape.

Discussion:

The contractors had removed the cement/stonework in several places along the length of the building in order to reveal the surfaces of the beams, and also the exposed 'T' tie-bars that had been embedded within the outer wall of the building.
This revealed that there was quite a variation in the condition of the beams, because some of them had corroded quite heavily whilst other beams were still in a really good condition with a smooth, clean surface.

This clean and smooth type of surface would enable both bristle-blasting and needle-gunning to be used to achieve an acceptable surface-roughness, without the extra time required to remove corrosion products and things like mill-scale.
There are, however, two important considerations to be factored-in when making the decision on the choice of preparation to be used on these beams, and why the logical choice is needle-gunning:

1. The allocated 'noise window' of only two hours per day would only allow, in theory, a total area of two square metres per day to be treated. In reality, it would be even less area than this, as the bristle-belts have to be changed after each square metre has been treated.

   There is, furthermore, the problems with getting the bristle-belts into sharp 90^{o} corners and internal box corners with a three-dimensional box, where it is a physical impossibility to treat the center sections with a circular bristle-belt, whereas a needle-gun can easily access these areas.

2. The cost of the bristle-belts is prohibitive, and whereas a set of needles can be re-sharpened and re-used a great many times, a bristle-belt is a 'one-shot' consumable item.

Theory and practice:

As this was discussed in the previous report, it will merely be confirmed here that needle-gunning can provide an adequate surface profile for the application of the Zinga film galvanising system, and it has in fact been used on the preparation of bridge-deck sub-structures etc.

As stated previously, any steel surface that has been blast-cleaned, bristle-blasted or needle-gunned correctly will always demonstrate a matt finish all over, due to the rough blast-peaks absorbing incoming light rays, and this is always a good and immediate indication of a surface-roughness being present.

Needle-gunning has been used for steel preparation on both offshore and onshore steelwork for several decades, and one of the advantages it has over other methods (with the exception of blast-cleaning) is that when working on inside corners and contours, the needles are self-adjusting.
This means that they can reach into deeper recesses within in the centre section of the needle bundle, whilst the needles in the outer section of the bundle may be striking a target-area that is closer to the operator, and this I all happening at the same time without any adjustments being necessary to the needle gun itself.

When working with Zinga, it is highly recommended to maintain the needles sharpened at all times, and to always keep several spare sets on site to avoid any delays.

Photographs with comments:

1

A corner section with the cement and facia removed

2

Heavy corrosion is prevalent along north east wall

3

The beams on the south-east side have no corrosion

4

Massive volume-expansion of corrosion products

5

Needle-gunning a test-area

6

The profile shows that the needles are a bit blunt

Larger photographs to show detail

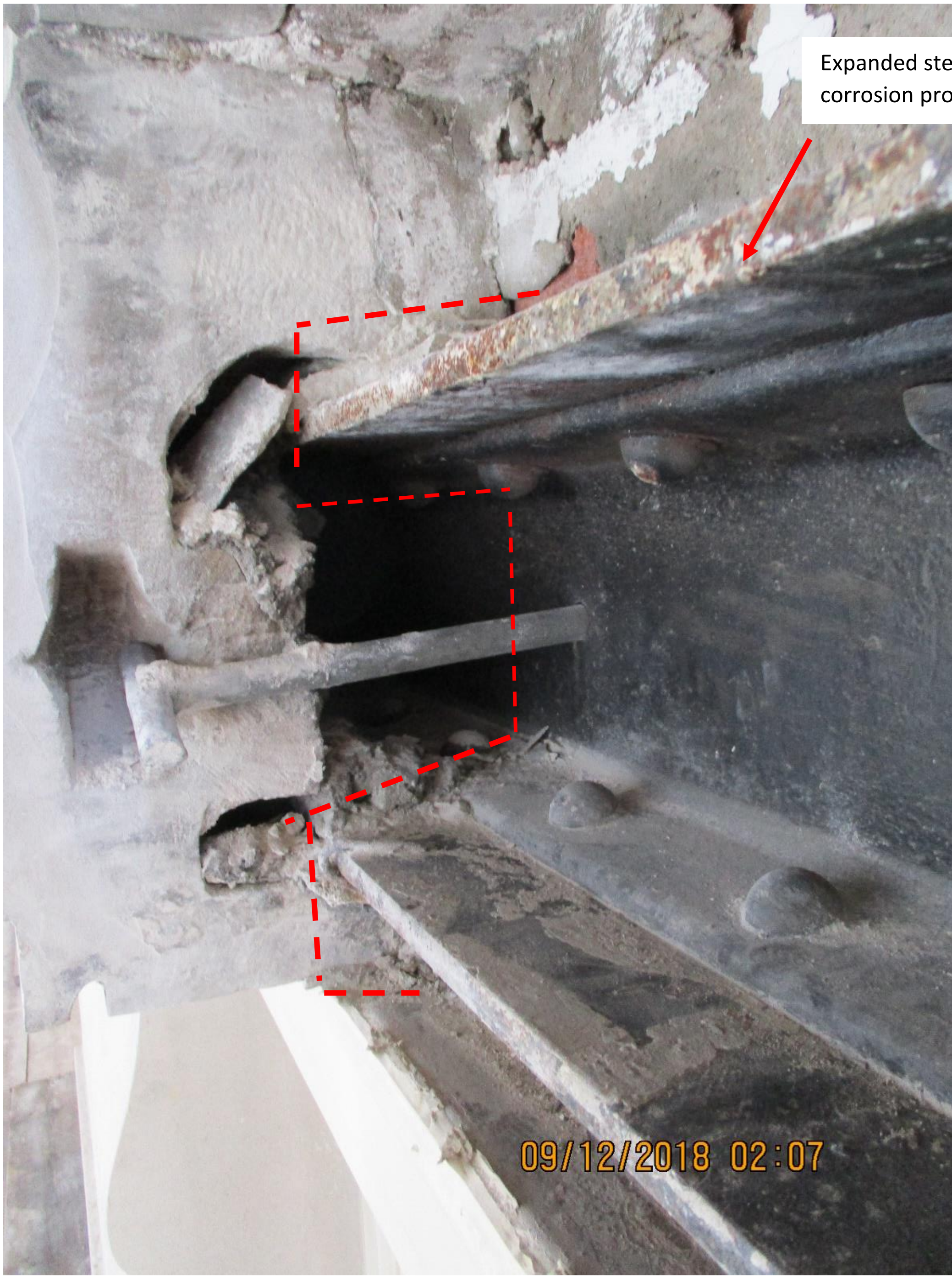
7

Photograph #6 enlarged here to show the surface-roughness better, as the lighting was a bit poor.

8

The beams on the south-west side of the building have no corrosion at all.

9



Exposed beam and 'T' tie-bar. The dotted lines show the air-gap being built in when closing up. The new cement will have a gap of 25 mm between the steel and cement to allow for volume expansion of corrosion products over the next 100 years or so.

10

Another area where the expansion of corrosion products on the beam is putting pressure on both the inner cementitious layer and the outer stonework. This is no different to the spalling seen on reinforced concrete.

11

The previous pointing on the steelwork is not compatible and is breaking up. This could potentially allow the ingress of water/water-vapour that can have a long-term effect on the steel beams.

12

The first test-area being coated with Zinga

13

The first test-section is coated so that the application quality can be evaluated and the drying-times observed.

Comments Page

1. It appears that, for some reason, the corrosion phenomena taking place on the steel beams, known as "Regents Street Disease", is only affecting the beams on the north-east face of the building. As the cement and stone cladding would have been done around a similar time-period on various sides of the building, it is quite bizarre that only this face appears to have been affected.

2. The removal of the corrosion products will take the steel back to a clean surface, and the surface roughness provided by the needle guns is designed to provide a very high bond-strength between the steel surface and the zinc coating n top. The high bond-strength will ensure that there is a good 'throw' from the zinc layer, which provides a linear polarisation to the steel surface (circa 1100 mV) up to a distance of 15 mm, providing full cathodic protection to any exposed areas of steel, including pin-holes or 'missed' edges.

3. Zinganised steelwork, including rebars in concrete, will normally have an extension of service-life of around 20 years, because the high ph of the cement/concrete will passivate the zinc layer for a great many years, and when the passivation eventually breaks down the zinc will continue to protect the steel surface.

4. Once the cement on the surface of the zinganised steel surface has been fully hydrated and has dried out, the zinc oxide on the surface of the zinc has already migrated into the open pores of the cement/concrete that is adjacent to the surface of the steel, blocking them. This effectively slows down the rate of any carbonation processes taking place, especially in cities, and can extend the expected service-life by twenty years or more.

5. In this current situation, the air-gap around the steel will allow the zinc layer to cure and toughen-up as per a normal atmospheric exposure, and there will be no direct contact with the cementitious rendering that is to be applied.

6. As Zinga is used on rebars within large concrete projects (ie longest concrete bridge in the world: Hangzhou Bay Bridge – 35 km in length) any contact with cementitious products has no affects whatsoever. Where it is now only going to be exposed to damp air, there is nothing to react with it or attack it.

7. Zinga is rated for ISO 12944 C5 -M/I (very high), IM-2 (saltwater immersion), IM-4 (offshore salt water immersion) and the new CX (offshore atmospheric), so the expected service-life on these beams is going to be extremely long, and probably exceeding 50 years.

Conclusions Page

1. The company 'Stonewest Ltd' has purchased a number of needle-guns and sets of spare needles, so they are fully equipped to take on the surface preparation of the steel beams.

2. They have done a test-application, and they are fully aware that a minimum film-thickness of 180 µm DFT of Zinga must be applied onto the surfaces of the prepared beams.

3. They have demonstrated a full understanding of the WFT (wet-film thickness) versus the DFT (dry film thickness).

4. They have clearly demonstrated that they have possession of, and know how to use, a wet-film gauge (aka a 'paint comb') and that a WFT of 150 µm is the minimum required for each coat.

5. The team know and understand that it will require two coats, with the second coat being applied one hour after the first coat has become touch-dry.

6. During the application on the test-area situated on the north-east/south-west corner on the 8th floor, the following ambient conditions were measured:

   a. ambient temperature: 14.7^{o}C

   b. Steel temperature: 14.4 ^{o}C

   c. Dew-point temperature: 4.2 ^{o}C

   d. Temperature variance: 10.2 ^{o}C

   e. Humidity level: RH 47%

7. The rebuilt facias will have an air-gap of 25mm between the cement/stone outer facia and the steel beam surfaces, so there is a built-in allowance for the volume-expansion of the steel corrosion products.

8. The dampness and available oxygen within these air gaps will allow the Zinga layer to fully carbonate in the same way as a hot-dip galvanizing layer would, and this toughens the coating as normal. Any carbon dioxide that is available will be used as part of the carbonation process on the zinc surface.

9. The previous set-up with the steelwork being embedded within the cement, and with the stone facia on top of the cement, produced an 80-year service-life. With the zinc layer on the steel surface, and having no direct contact with the cement (for any reactions with the water/damp conditions) should offer a service-life in excess of 100 years before any maintenance will be required.