A CONSERVATION STUDY OF

A Terra-Cotta Building

Circa 1917-1918

By: Professor Martin E. Weaver, AA Dipl

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INTRODUCTION

This Terra-Cotta Building was built 1917-18 as the Norlite Building and was designed by Richards and Abra with C.P. Meredith.

From an examination of copies of some of the original drawings for the building, it was apparent that the building was constructed with a reinforced concrete frame and floors; and was clad on its North with off-white glazed terra-cotta cladding. The terra-cotta cladding was returned round the East and West façade for one bay, and small, terra-cotta clad towers were formed one and a half storey's high above the main parapet wall at the North West and North East corners. These two small towers were designed to be capped by copper-clad domes; and the parapet was decorated with two free-standing terra-cotta urns on bases or acroteria. Both the domes and the urns have disappeared.

The first studies on the Building commenced when Martin Weaver was commissioned to carry out a brief examination of the North or main terra-cotta façade in November 1993.

Martin Weaver had initially been requested to advise on the repair of the terra-cotta cladding on one of the piers at the 7th and 8th storey's (Bay 4 numbering from the East) and to make a proposal for further studies if these should be found necessary. In the course of the initial study Martin Weaver found that parts of the terra-cotta cornices on the East and West towers were in a dangerous state and in need of immediate stabilization. The risk of injury to pedestrians on the sidewalks beneath was in fact so serious that barriers need to be erected immediately. These observations were forwarded directly to the client.

The terra-cotta work was found to be generally cracked in a number of places and bowed and cracked away from the main structure in others. Mortar, stucco and other repairs were also showing signs of failure.

THE CONDITION SURVEY

Martin Weaver was thus commissioned to make the study, and the condition survey was carried out from a personnel basket suspended at the end of the cable from the jib of 110 ton mobile crane. The survey was carried out in very poor weather with snow and extremely cold windy conditions in December 1993. The temperature with the wind-chill factor was often lower than -25°C.

Parts of the structure were obscured by snow and thus could not be surveyed. Every part of the exposed external surface of the terra-cotta work was examined closely and loose and dangerous fragments were removed from the building wherever possible.

As a result of the writers' immediate observations a second emergency report and recommendations were issued. The object of these recommended works was to remove risk of injury to the public which might be caused by falling fragments of terra-cotta.

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OBSERVATIONS

The problems of the terra-cotta cladding of the Building are typical of such structures and materials of the period of the golden era of architectural terra-cotta from the early 1900's to the 1920's.

It may be helpful to list the major deterioration categories which were present in this case:

1. Over a long period of time a combination of initial shrinkage and long term "frame-shortening" of the reinforced concrete frame of the building has tended to transfer loads onto the relatively thin terra-cotta cladding. The terra-cotta units have thin brittle walls and fail in compression, usually cracking horizontally at their mid-points, or suffering from spalls at their loaded upper edges and sometimes lower edges (see for example areas W7-8); the sides of the terra-cotta units usually tend to have a slight recess immediately behind the outer edge, the resulting projections over and under the bed joints then tend to receive the concentrated loads; units in cladding which is loaded in this way may also buckle outwards and may cause extremely dangerous conditions to develop if the anchors are corroded; or are insufficiently numerous or if they break out of the brittle terra-cotta. This might also be a part of the problem with the cornices on the East and West Towers.

2. Leakage of water into the wall, usually from open joints in skyward-facing surfaces, can lead to freezing water within the wall and to the terra-cotta units being forced off the walls; or the water can cause corrosion in hidden steel anchors and rods which were used to tie the cladding back top and the back-up brickwork or to the concrete of the frame, columns or edge beams; in which cases the damage was probably also the main cause of the failure of the cornices on the East and West Towers.

3. Localized spalling and exfoliation of glaze/slip coats caused by water being trapped in the terra-cotta body behind the latter;

4. Surface cracquleure on some blocks where "lack of fit" or differences in thermal expansion coefficients cause the body to shrink or expand more, and more quickly than the glaze/slip combination;

5. Extensive failures of joints; failures of ineffective repairs to jointing and pointing and failures of repairs to previously damaged terra-cotta have all contributed substantially to the entry of water behind the terra-cotta cladding where it can freeze or cause corrosion in hidden steel anchors;

6. Extensive failures of cementitious repairs where original balconies or terra-cotta and ironwork have been removed (8th storey North façade) have contributed to the entry of water with the results noted in the above case; there was also a failure to remove all of the associated with the balconies and this has led to continuing corrosion causing expansion, cracking of the terra-cotta and renders, and extensive rust staining.

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REMEDIAL ACTION AND RESTORATION MEASURES

The tops of the two towers should be carefully dismantled after first recording them and numbering all the terra-cotta units. The terra-cotta work should be dismantled at least to the level of the base of the cornices as indicated on the drawings. After the security of the masonry has been established and a sound level has been reached, the terra-cotta and the brick back-up masonry can be rebuilt.

All corroded steel anchors, cramps, ties and other terra-cotta cladding-attachment devices must be carefully removed and replaced with appropriately designed replacements in stainless steel (AISI Type 304).

All shattered and irreparable terra-cotta units should be replaced using new units of fine-faced pre-cast concrete or fiber reinforced plastic carefully fabricated to match original dimensions and surface finishes including fine ribbing or "tooling". It would probably not be practical to obtain the small number of replacement units required, using actual matching terra-cotta. Delivery times for terra-cotta would normally be a major problem.

The entire terra-cotta cladding must be tied back to the back-up masonry in such a way that the load of the cladding is transferred back onto the reinforced concrete edge beams on the floor slabs. This tying back should be effected by the use of specifically designed Cintec grout injection anchors, which are the only type that can effectively be used in this case.

Once the cladding had been tied back and effectively stabilized, all the mortar joints in the terra-cotta work should be carefully cut out and the caulking or sealants removed. This work of mortar removal must be carried out with great care using small diameter diamond saws (120mm diameter) and specially designed diamond impregnated router bits. Both should be used with pneumatically powered tools with attached dust extraction intakes. Special care should be taken to ensure that the terra-cotta blocks are not damaged by over-cutting or "Straightening" of bed joints or by over-cutting or "nicking" at the top and bottom of vertical joints.

Replace all jointing and bedding mortar with a mortar mix of 1;1;6 p.b.v. (non staining white Portland cement) hydrated lime sand with 16% entrained air obtained by thoroughly machine mixing for approximately 8-10 minutes.

The purpose of the entrained air is to confer and freeze/thaw cycle resistance.

One bed joint at each storey immediately at or below the floor slab should not be pointed with mortar but should be pointed with a high quality dymeric or similar caulking compound or sealant, to produce a soft compressible joint, thus preventing compression of the panels of cladding between floor slabs.

Prior to any cleaning of the masonry, all corroding steel and ironwork, bolt stubs, and redundant electrical conduits, junction boxes and brackets should be removed from the Masonry and the holes made good to match surrounding material. Embedded bolts and fragments of bars or rails should be drilled out using a diamond-tipped coring bit of slightly larger diameter. The resulting hole should be plugged with a limestone core in limestone and with a Jahn Terra-Cotta Restoration Mortar in the terra-cotta. The latter shall be carefully matched to the original color and texture of the terra-cotta. Spalls in the terra-cotta and areas of failing cementious repairs in the terra-cotta should be carefully cut out as necessary and should also be repaired with matching Jahn Terra-Cotta Restoration Mortar.

Slight losses of the glaze/slip coating should be repaired after cleaning of the terra-cotta, by the application of a tinted breathable masonry coating carefully selected to be color matched to the original terra-cotta – ie, a light cream-stone color. The known appropriate coats are:

Conservare BMC, ProSoCo, Kansas City, Kansas US
Keim Granital, Keim gmbh, Germany
Minasil Mineralfarben, MCS Chemie, Salzburg, Austria

Field testing and research of the selected manufacturer's literature would be required to determine if the above coatings could be applied over the Jan Mortar repairs.

Following a carefully organized test program, the rust stained and soiled terra-cotta should be cleaned. The limestone cornice of the 2nd storey should also be repaired and cleaned.

Spall damage should be repaired by careful cutting out and the insertion of matching Indiana Limestone Dutchmen. Cleaning of the limestone should be by means of nebulous spray washing and limited use of neutral, non-ionic detergents such as Triton X100. Following appropriate testing and the establishment of successful techniques, rust staining may be removed using Ferric Stain Removing Poultices from ProSoCo.

BRICK FACADES

The east, west and south facades, except for the terra-cotta returns at the north end of the building, are clad in a fired clay brick, which has been painted.

However, observation from the ground with binoculars and from the observation bucket indicated that these walls were in no immediate danger.

Deterioration was noted at shelf angles at a number of locations, particularly near the top of the building. This appears to be typical damage caused by the expansion of products of corrosion of the shelf angles.

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EXECUTIVE SUMMARY

The terra-cotta cladding on the building was suffering from moderate to severe deterioration at a number of locations.

Two areas, the towers and the mullions between windows, were in a very dangerous condition and had to be repaired immediately.

The main causes of deterioration are:

1. Frame Shortening
2. Leakage through open joints
3. Local spalling and exfoliation
4. Cracquelure
5. Joint Failure
6. Cementious repair failure

The repair strategy included:

1. Dismantle and rebuild towers
2. Remove and replace corroded anchors
3. Tie back and transfer terra-cotta load
4. Remove and repair all joints
5. Provide a soft joint at each storey
6. Remove add-on and patch
7. Patch glaze/slip with BMC
8. Repair limestone cornice
9. Iron stain removal
10. Clean terra-cotta