MANTICORE
ENGINEERING LTD.

Project No. 5041.12

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OCP 831 0969 (o/a Westmount Place)
c/o Montgomery Ross & Associates
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Calgary, Alberta
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Emailed to Vicci.OBrien@MontgomeryRoss.ca

Attention: Ms. Vicci O'Brien

RE: WESTMOUNT PLACE – UPPER FLOORS POST-TENSIONING SYSTEM REVIEW

1.0 Introduction

At the request of Montgomery Ross & Associates, on behalf of OCP 831 0969 (o/a Westmount Place), a review of post-tension cables in selected upper floor slabs is complete. The purpose of the review is to qualify the condition of the post-tension cables in these slabs, and to provide recommendations for analysis, repair, replacement, upgrading, or additional investigations.

A report on the main floor and underlying parking slab post-tension cables was provided June 27, 2012.

2.0 Description of Structure

Westmount Place is located at 1100 – 8th Avenue SW in Calgary. The facility is a 28 storey residential/commercial building with a four level underground parking garage. The building is primarily clad with brick and curtain walls. Building amenities include a swimming pool and hot tub at the east of the 4th floor.

The building is a reinforced concrete frame structure. The floor slabs are reinforced with unbonded, post-tensioned cables supplemented with conventional reinforcement. The post-tension system is a 'two-way' system with groups of cables distributed at approximately 4' on center in one direction and banded over column lines in the perpendicular direction.

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3.0 Background

Unbonded post-tensioned slab construction became popular in the early 1960's because it provided a more economical alternative to conventionally reinforced slab construction. Post-tensioning also minimizes the number and size of cracks and therefore reduces moisture and chloride (de-icer salt) penetration into the concrete which threatens the durability of the slab.

In recent years there has been a growing awareness of durability problems associated with unbonded post-tensioned construction. The reduced durability has been noted with certain installations and has generally been a result of poor design details, unintentional exposure to corrosive environments, or poor construction practices.

Reduced durability results from moisture contacting the cables leading to corrosion and fracture. Moisture can potentially enter the plastic sheath during transportation of the material to site, and/or while stored on site, and/or while in place on the formwork before concrete placement. Moisture and other contaminates can also enter the sheath following construction through stressing anchorages, through the concrete pore structure, or through cracks in the concrete. Experience with post-tensioned slabs indicates that the greatest frequency of damage corresponds to systems which contain unprotected stressing anchorages at or below grade.

A limited sampling or evaluation of post-tensioning cables at inspection recesses provides non-conservative results. An individual cable is reviewed by exposing approximately 200 mm of its total length (test site), therefore, only a small fraction of its total length is observed. A cable in good condition at the test site may be corroded at a location nearby and it is the corroded location that governs the durability of the cable. Corrosion damage can only be confirmed if the cable is corroded at the test location or if the cable is completely removed for examination.

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4.0 Review Methodology

The review program consists of four parts:

- View architectural drawings provided by the client to select areas for review. These drawings do not include details of slab reinforcing.
- View visible concrete construction and waterproofing.
- Install recesses in slabs' soffits to expose post-tension cables
- View cable condition and complete 'penetration' tests to qualify stress.

After testing is complete, fire resistant insulation and steel cover plates are installed at the slab soffits to conceal recesses.

As-built structural drawings and post-tension shop drawings are not provided.

5.0 Observation and Discussions

5.1 Waterproofing

The majority of the post-tensioned slabs are in a dry service environment inside the building envelope. These dry service areas are at a low risk for in-service water ingress and do not require supplemental corrosion protection such as a waterproof system.

Sections of the slabs that extend beyond the building envelope and some areas within the building are exposed to wet service environments. These include the balconies, swimming pool deck, and mechanical rooms.

Mechanical rooms are below the pool, at the west of the 3rd floor, and in a penthouse. At these locations waterproofing is essential to limit moisture contacting the concrete reinforcing (cables and re-bar). Prolonged exposure will result in reinforcing corrosion and concrete deterioration.

Balcony slabs are not waterproofed and are often carpeted or tiled. Balcony soffits are either bare concrete or painted. Unprotected anchor pockets are visible along the slab edges. Some staining indicating through slab leakage is noted at the soffit of larger north elevation balconies.

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Roofs are covered with roofing systems overlain with gravel, wood decking, or other finishes. It is assumed that the roofing systems are performing and are monitored by others.

The pool room finishes include painted gypsum board at the ceiling and floor tile. A number of delaminated tiles and deteriorated grout is observed. Control joints are not apparent. Tiles are not removed to view the slab below. The pool coating is assumed to be maintained by others and is not included in this review.

The majority of the top slab surfaces at the 3rd floor and penthouse mechanical rooms are painted. The paint appears to provide some protection from moisture.

In the pool mechanical room, including the space below the pool, a concrete curb and roofing type membrane are installed on the floor. Leakage from the pool equipment into the suite below and to the exterior is reported. Staining of the ceiling tiles in the suite is confirmed. The membrane appears to be dated and detailing is questionable. The condition of the equipment is not part of the scope of this review.

5.2 Concrete

Visible concrete appears generally sound with some exceptions. Cracking noted at larger north balconies does not appear to be structurally significant. Some spalling is noted at balcony slab edges. The slabs have not been sounded to confirm delaminations.

Anchor pockets are confirmed at north balcony edges and one at an east slab edge. The condition of the pocket mortar varies from sound to absent. Where installed, the mortar is a lower quality than the slab concrete. Surface corrosion of a cable end is noted at an anchor pocket were mortar is absent.

5.3 Post-Tension Cables

Post-tensioned cables are of the extruded type. These are at lower risk to water ingress than the more common ‘push-through’ type.

Two inspection recesses installed below the pool room slab did not contain any cables. Conventional reinforcing was observed and did not exhibit any corrosion damage. Those recesses have been patched.

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Table 1 summarizes the "penetration test" results of 60 cables viewed at 21 recesses in the upper floor slabs.

Table 1
Summary of Observed Cable Conditions

Cable Locations	No. of Cables	No. of Cables Unstressed
5th floor	19	3 (16%)
6th floor	6	0 (0%)
8th floor	2	0 (0%)
10th floor	3	0 (0%)
12th floor	4	0 (0%)
13th floor	1	0 (0%)
15th floor	6	0 (0%)
17th floor	4	0 (0%)
18th floor	2	0 (0%)
20th floor	2	0 (0%)
21st floor	2	0 (0%)
penthouse roof	9	0 (0%)

All cables from the 6th floor to the penthouse appear stressed. An adequate layer of grease is noted, and water and corrosion products are absent.

Three of 19 cables (16%) are unstressed at the 5th floor. Two of 16 (13%) cables are unstressed in the north beam and 1 of 7 (29%) unstressed in the adjacent beam. This percentage of unstressed cables is greater than the generally accepted upper limit of 10%.

The unstressed 5th floor cables are located below a roof and above the swimming pool, both potential sources of water. At a pre-existing drill hole, a cable was struck by the drill. This cable appears to be stressed.

The reason these 5th floor cables are unstressed is not known. Possible causes include corrosion damage, mechanical damage from building construction or renovations, or the cables were not stressed during construction.

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6.0 Conclusions and Recommendations

6.1 Waterproofing

Balconies are not waterproofed and the slab concrete and reinforcing are exposed to moisture and atmospheric carbon dioxide. Some concrete deterioration is noted and will increase over time. Carpet on the balconies without an underlying waterproofing layer is detrimental.

Installation of a waterproofing coating on the top surface and edges of balconies is the generally accepted industry recommendation for this type of construction. This is to reduce the corrosion potential of any conventional reinforcement, and to limit the potential for water to contact the cables. These cables are most prone to water entering at the anchors and it takes little water to start the process that leads to cracks propagating in the steel.

Confirm waterproofing performance in the pool and underlying mechanical areas, and repair or replace if performance is poor.

6.2 Concrete

The balcony concrete appears sound. It is recommended that the slabs be sounded prior to waterproofing, and repaired if delaminations are present. Repacking of unsound anchor pockets is required prior to waterproofing.

6.3 Post-Tension Cables

Cables viewed and qualified on the 6th floor and above appear to be sound. Repairs to cables above the 5th floor are not required.

Determining the reason that cables are unstressed at the 5th floor is required in order to provide recommendations. Removal of the cables will confirm the location of the breaks, or if the cables were originally not stressed. This action is recommended. Possible outcomes are to restress the 3 cables, repair them, install new cables, or expand the exploratory work.

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Ongoing monitoring of all cables is recommended. It is important to assess the risk of further deterioration. This work can be completed on a biennial basis. It is estimated to cost in the order of $3,000 to complete.

7.0 Closure

The evaluation program has not included a review of the structural design of the slab. It has been assumed that the slab was designed and constructed in accordance with all standards and codes of practice applicable at the time of construction.

The intent of this reporting was to identify situations that are obvious to a professional engineer under the current terms of reference. The conclusions and recommendations presented are based on a limited cable sample size and may not represent all cables conditions within the slabs and conditions may vary widely away from the probe sites. If new information comes to light, Manticore requests the opportunity to review this information.

The consultant cannot and does not warrant or represent that bids or negotiated prices will not vary from the construction cost estimate. There is no cost condition or representation that the project can be completed for the amount of the construction cost estimate or any other amount and the client expressly waives its right to withhold the consultant's fees, either in whole or in part, or to make any claim or commence an action or bring any other proceedings in any court of law against the consultant in connection with advice or information relating to the construction cost estimate whether in contract, tort or otherwise.

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We trust this information meets with your present requirements. Should you have any questions please contact Manticore Engineering Ltd. at (403) 252-8454.

Yours truly,

MANTICORE ENGINEERING LTD.

Richard Haener, C.E.T.

Reviewed by

5041.12
Jeff Small P. Eng
Principal
January 8, 2013

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