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CANADA MORTGAGE AND HOUSING CORPORATION

Better Buildings

Issue 1

• BUILDING ENVELOPE SERIES •

Project: High-Rise Masonry Wall Rehabilitation

Overview

Controlling Cost and Disruption

This case study illustrates the innovative thinking that went into controlling the cost and disruption typically associated with major repair and renovation. The project, which was undertaken over two summers at a cost of $1,500,000, successfully repaired the collapse of the masonry wall system for a high-rise, multi-unit condominium. At the same time, the exterior of the aging building was given a new lease on life.

The Problem

In 1991, a 12-storey, 177-unit condominium in Ottawa, Ontario ran into trouble when the bottom two storeys of a masonry wall section collapsed (photo 1). The primary objectives of the project were to prevent further collapse, to protect safety and to prevent liability. Secondary objectives included the elimination of troublesome water leakage, improvement of occupancy comfort and the minimization of future repair costs.

Assessment

The property manager called on a consulting engineer to explore the reason for the collapse, to see if other failures were impending and to recommend a repair strategy. In order to determine the extent of the problem and the kind of remedial measures required, the engineer began with a condition survey, which revealed the following:

1. The masonry wall system was not horizontally reinforced.
2. A covermeter survey and the opening of walls at various points revealed that the vertical reinforcement was poorly spaced and grouted and significantly corroded.
3. The vertical reinforcement was seldom connected to the floor slabs.
4. The brick overhang at the slab edges exceeded specified dimensions.
5. Through-wall flashings had been installed but no weep holes.
6. The adhesive between the insulation and masonry was largely ineffective.
7. Soft joints had not been installed consistently to allow for differential movement between the concrete structure and masonry.
8. The queen closer units had not been secured to the floor slab structure.

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Repair

Armed with the results of the engineering study, the project team considered two alternative repair strategies:

Option 1
Strengthening and securing the existing masonry wall system and installing new soft joints to allow differential movement between the masonry veneer and the structure.

Option 2
Replacing the TTW masonry wall system with a brick veneer-steel stud wall system while maintaining the interior finishes.

Ultimately, Option 1 was rejected because of the cost of repairing the wall system would not have been substantially less than replacing it. Furthermore, repairs would not have addressed the possibility of other undiscovered problems, and an ongoing repair strategy would have been needed to deal with emerging problems as the wall system aged.

Option 2 was preferred because of reasonable cost and the thoroughness of the repair. Moreover, it was also discovered that – because the original construction adhesive had failed — the outer masonry wall system could be replaced without major disruption of the interior wall finishes. The occupants of the condominium were pleased because they did not have to vacate their apartments during construction, and the level of disruption was tolerable.

The Work

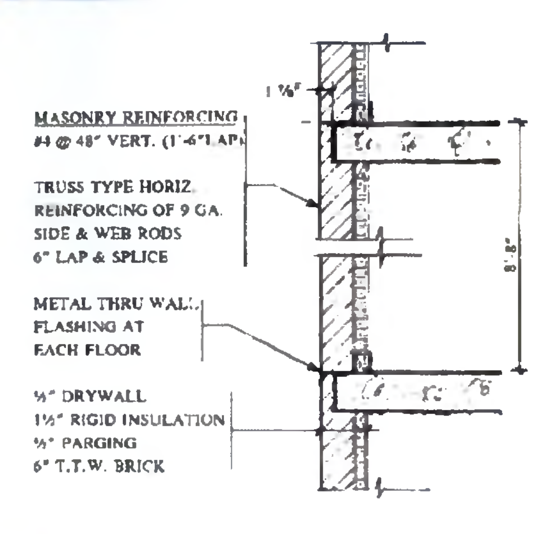
Construction: Section by Section

The original wall assembly consisted of 150-mm TTW clay bricks, 12-mm parging, 38-mm expanded polystyrene insulation and 12-mm drywall (detail 1). The brick walls were supported directly at each floor level. A queen closer unit covered floor slabs to give the appearance of a continuous brick veneer. Vertical strips of window-insulated metal spandel panels divided the masonry walls into vertical sections ranging from 1 m to 4 m in width.

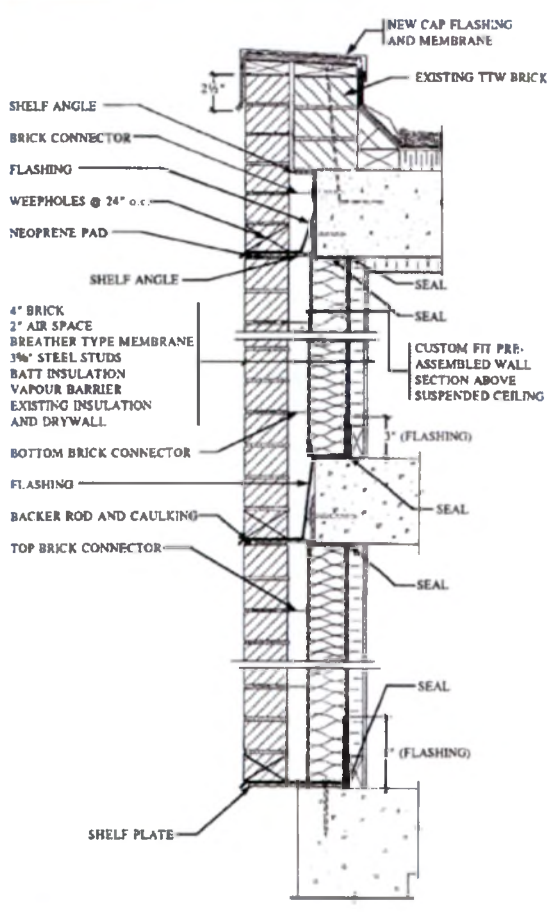
The repair strategy called for the outer masonry wall to be demolished while leaving the original rigid insulation and gypsum board in place. This strategy was applied to a test section of wall to confirm that it would work. After the outer wall was demolished, a new steel stud-brick veneer wall system was installed (see Detail 2). Repairs were conducted as follows:

1. The building was scaffolded in 10-m lifts, and the TTW brick masonry demolished from the top down, one floor at a time.
2. The joints in the existing polystyrene insulation (which remained in place) were caulked and a new polyethylene vapour retarder installed.
3. A made-to-measure steel stud wall system, complete with wrap-around brick tie brackets and internal bridging brackets, was assembled on the ground, then hoisted into position to support the existing drywall. As the building

Detail 1



Detail 2



was fully occupied during the repair work, the new wall framing system had to be installed on the same day that the original wall was demolished – again, one floor at a time.

4. The crew, working from inside the units, used fasteners to secure drywall and rigid insulation to the framing system, then patched and finished the fasteners.
5. On the exterior, the steel stud wall system was filled with RSI 2.11 fibreglass batts and then a breathable air barrier was installed.
6. When work reached the ground level, the construction of the new brick veneer commenced, with 100-mm clay bricks being laid with a 50-mm cavity behind. Shelf angles were installed at each floor level to support the bricks.

Contract Management

The contract was let through a competitive bid process, with a performance bond equal to 50 per cent of the total contract being required of the winning contractor. The lowest bid – which came from the contractor who had helped with the initial investigation and trial repairs – was accepted on the recommendation of the project consultant. The contractor entered into a Stipulated Price Contract (CCDC 2), thereby taking responsibility for scheduling, performance and coordination of work, while the consultant agreed to undertake general site review, chairing and recording site meetings, preparation of site review reports and approval of contractor invoices.

Scheduling

The work was conducted on weekdays during the summers of 1992 and 1993, with the project closing down in winter to avoid the costs of erecting site hoarding and providing heat, etc. Project planners responded to the financial constraints of the occupants by spreading out the work in keeping with available condominium cash flow. The work plan also took into account the occupants' desire to have only parts of the building and grounds encumbered by construction at any given time. Each 10-m work area took approximately three weeks to complete for the full 12 storeys.

Project Management

The collaboration of building owners, managers and a project consultant contributed strongly to the success of the project. Together, these various parties reviewed the two principal repair options and prepared repair specifications. The effective working relationship that developed was instrumental in identifying and resolving problems before they could interfere with the work in progress.

Costs

The cost of construction, which was funded through a special

assessment levied by the condominium board, amounted to \$1,500,000 plus GST. The cost of individual repair items as follows (based on masonry repairs over an area of 3,460 m^2):

Mobilization, supervision, cleanup	\$600/suite
Demolition	\$35/m^2
Stud wall system	\$85/m^2
Scaffolding	\$74/m^2
Brick reconstruction, related work	\$205/m^2
Interior drywall repairs	\$316/suite

The Outcome

Implications for Operations: Minimal DIsruption

Efforts were made to avoid inconvenience to building occupants during the project. In particular, construction was restricted to weekdays from 7:30 a.m. to 5:30 p.m. Also, work was carried out floor by floor and section by section so as to leave large parts of the building unencumbered at any given time. Nevertheless, there was some unavoidable disruption, as residents were unable to use their balconies and common grounds in the work area. Also, crews had to enter units in the work area to secure the existing drywall and insulation to the new steel stud wall system and to plaster over fasteners.

Results

During construction, a "monitored" brick fitted with thermocouples and moisture sensors was installed in one area to test the performance of the wall system. Similar monitors were set in the stud wall behind the brick, and pressure taps were installed through the wall system. The sensors were connected to a data logger in one of the apartments, and data were recorded for the first few months after construction. Observations indicate that the wall system is performing well in terms of thermal resistance, pressure equalization and as a rainscreen. Inspections to assess the performance of the new wall system have not been carried out; however, observations made during subsequent work (such as caulking, painting and window repair) have been favourable.

From the building owner's point of view, the project succeeded in improving the comfort of the occupants and in resolving safety issues related to the old wall systems. Moreover, water leakage at the floor slabs has been eliminated and the appearance of the building substantially improved.

Contacts

Owner:
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Property Manager:
PPM Professional Property Management Corporation

Consultants:
Keller Engineering Associates Inc.

Contractor:
Magus Restoration Inc.

For more information about building envelope solutions and best practices, visit the Canada Mortgage and Housing (CMHC) web site at www.cmhc-schl.gc.ca and visit the Highrise and Multiples site at www.cmhc-schl.gc.ca/research/highrise/