Figure 1: Raked mortar joints at brick veneer

170 Tremont Street

Thin Brick Seated Pre-Cast Failures

By Craig E. Barnes, P.E., SECB

The City of Boston has a high rise inspection program for buildings over 70 feet. The program requires a professional engineer or architect to review exterior facades to detect objects that might fall and injure the public, and report conditions on the façade that allow the introduction of water. Water introduction over a period of time could result in deterioration of the façade that would be harmful to the public. Inspection programs conducted on Boston buildings are frequently done with an at grade visual review, assisted by binoculars for upper levels and aerial platforms of some sort for the higher elevations. Adjacent buildings and adjoining building roofs may be used as well for points of observation. Unfortunately, some building owners will only respond to the need for a thorough review if there is calamity on their doorstep. Bowing to these pressures, the inspection has become a two part process. The City of Boston allows the professional to conduct a street level and binocular survey, the results of which may lead to an aerial lift observation. Buildings less than 70 feet will more than likely have deficiencies addressed only if observed by a City of Boston building inspector, a conscientious property manager, or arousal of the public caused by a falling object.

In early 2000, CBI Consulting Inc. was engaged to undertake the façade inspection of 170 Tremont Street, an 18 story condominium building in the heart of Downtown Boston. In the case of 170 Tremont Street, a binocular survey revealed minor masonry cracking on the brick façade. The existing construction plans were not helpful in determining the cause of the cracking. The record plans showed a precast concrete façade. The actual façade was a combination of brick and precast. This conflict between as-built plans and existing conditions reveals a possible pitfall if too much reliance is placed on as-built documents. Prior to the high rise survey on 170 Tremont Street, the owners planned a full sealant replacement at the existing windows to address leak issues. Knowing there was a potential need to address distressed brick, the property manager allowed for a limited allotment of brick replacement during the sealant replacement project.

When the sealant project was underway, it became evident that brick deterioration was far more extensive than anticipated. To understand what was taking place, we need to understand the construction of the panel. To achieve the brick look, the precast panels were seeded with cored red brick veneer during the casting operation. To enhance the brick feature, a raked brick joint was utilized. *Figure 1* shows how attractive the result is and also highlights gaps in head joints resulting from mortar erosion. The combination of the raked joint with the use of cored brick veneer created a condition conducive to the introduction and trapping of water, which lead to freeze thaw deterioration. In order to construct the seeded panel, the 1¾-inch thick bricks of the veneer were placed on a horizontal form surface, and spaced a mortar joint apart by use of rigid plastic joint strips used to achieve the desired brick spacing and depth of rake. A cement based mortar with properties of concrete was then placed over the entire rear brick

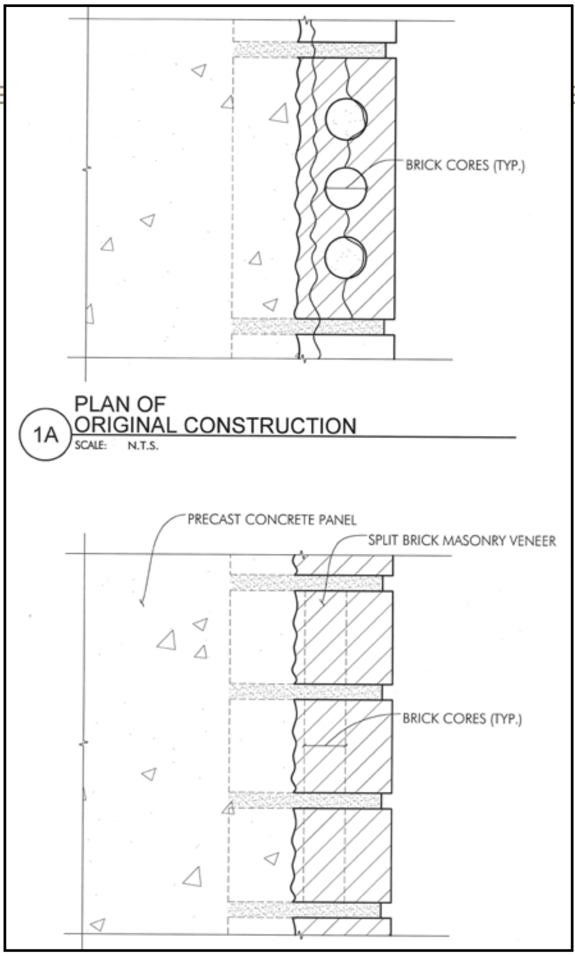

Figure 2: Illustrates bricks cast into concrete panels and the extent of veneer separtation

surface. This, we believe, was followed immediately by the placement of reinforcement followed in turn by concrete placed to the desired depth. The bond between brick, mortar back-up, and precast concrete was critical. When the panels were righted, the plastic joint strips were removed and the final product was the raked joint seeded brick panel. (*Figure 2*)

The phenomenon of deterioration of a raked joint mortar by water, combined with acid rain, is well documented. In the case of 170 Tremont Street, the deterioration of the mortar joint and thin shell between the brick core and the brick surface allowed moisture into the cores of the brick. Existing conditions revealed that there was no guarantee in the casting process that the brick cores would be solidly filled with mortar. Our review found solid filled cores and other cores

Figure 3: Brick excavation seen from the underside of the brick. Note the ragged horizontal crack through the cores of the brick

Figure 4: Panel with brick removed showing reinforcement in the concrete and the ragged freeze thaw fracture at veneerface

partially filled. Water setting in the raked joint and finding its way to the brick cores during freeze thaw cycles will expand when frozen, causing the brick face to fracture from the parent concrete panel (*Figure 3*). That was the problem that had been observed with the binoculars. Over time, one could imagine the entire brick seeded façade breaking loose (unzipping) from the concrete substrate.

The conditions presented several problems that a series of repairs were designed to correct. First, brick that had totally separated and was in danger of falling was removed. Full panel sized removals were conducted. The cored brick which was in the process of falling, or had peeled off, as well as the back-up portion of the brick still embedded in the concrete was removed. Once the brick and mortar was removed, the resulting panel surface was fairly smooth. Some areas contained exposed reinforcing rods (*Figure 4*). The reinforcing rods were in good condition and did not need to be replaced or supplemented, although slight corrosion was observed. The fact that there was rust on the reinforcement pointed out yet another problem that would occur down stream unless corrected. Due to moisture oxidizing the reinforcing within the panel, the reinforcing would expand and begin to push the brick off, creating another mechanism that would endanger the integrity of the system. Replacement or repair of these elements was accomplished in a traditional way. Exposed reinforcement of the concrete was cleaned and coated with epoxy. The concrete surface was cleaned, and an application of an epoxy mortar thin set was applied to the concrete surface. Mechanical ties were drilled into the concrete back-up and left exposed to be incorporated in the mortar joints of the replacement brick. A hot dipped galvanized steel relieving angle was placed at the bottom course of brick at a joint between the panel being repaired and the panel below (*Figure 5*). The relieving angle supported the brick, which was then placed in traditional fashion, with the addition of a solid collar joint of epoxy mortar. The concept of the rake joint was abandoned and the joints were pointed to be flush with brick surfaces.

The second condition addressed veneer brick, which was debonded but not dislodged over small areas. The repair implemented here was derived by viewing a number of the existing conditions which revealed, in all cases, that the original setting grout was very strong, bonded to the brick at mortar joints, and often remained intact even as a crack on the core line was initiated. Taking advantage of the strong well bonded mortar and abandoning the rake joint, which was a minimum of ⅜-inch deep, allowed for the re-securing of the veneer with stainless steel helical anchors. Once the anchors were set, the mortar joints were flush pointed. This process was used over the entire surface, both at the cracked areas and those areas that may not have been cracked. *Figure 6* shows the final condition.

At the conclusion of the pointing, the entire surface was clear sealed to add one more level of security against water intrusion.▪

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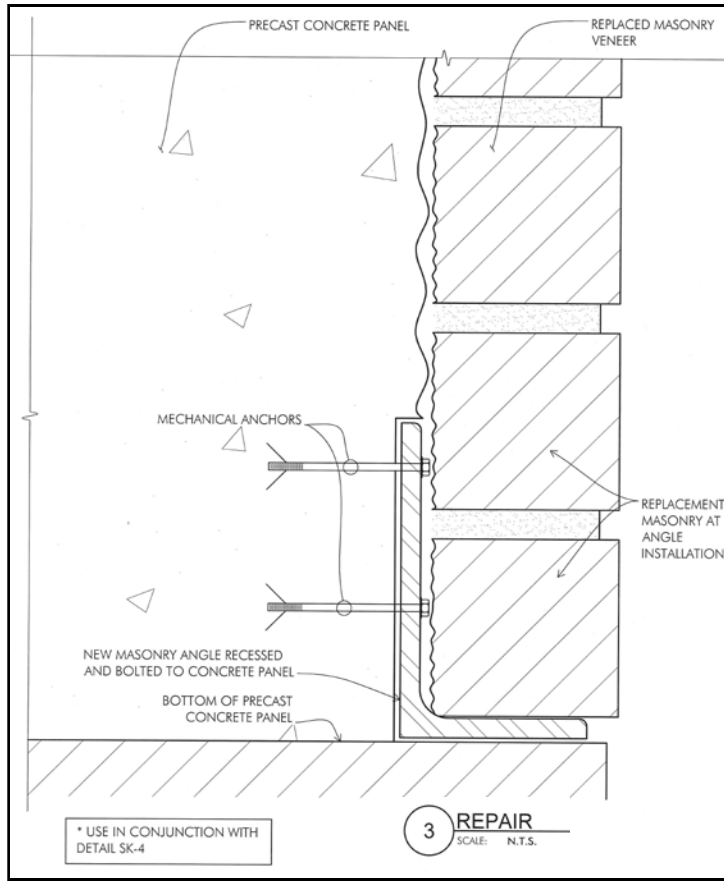

Figure 5: Section at new support angle

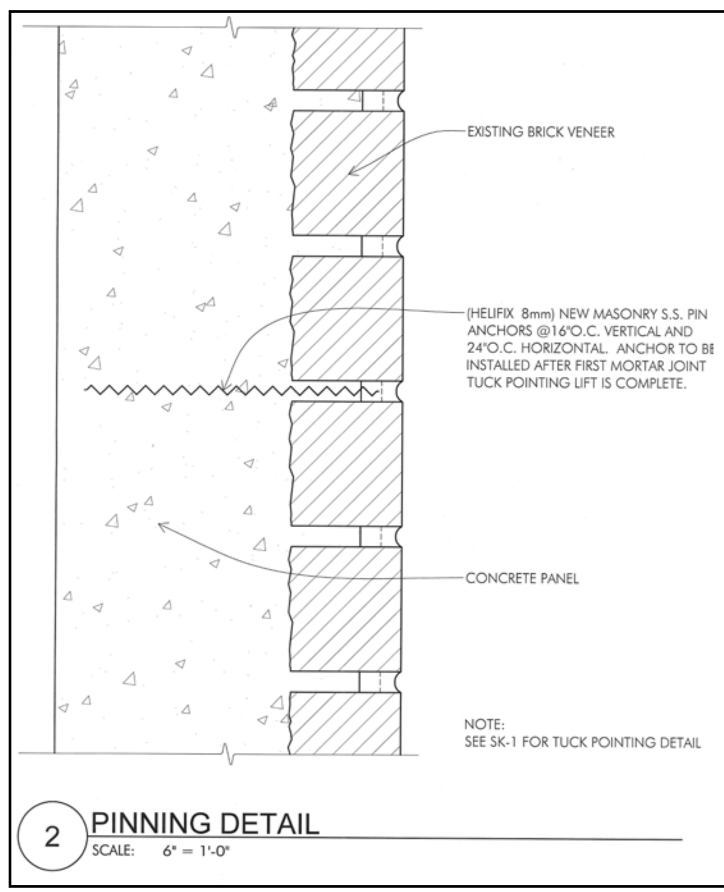

Figure 6: Wall section showing installation of helical anchors used to pin the veneer