I, there were regular surveys conducted of the interior floor and documentation was made of movement problems. Also included was the monitoring of drain performance with precise locating of movement problems. The observed result was that over 50% of the piers were unstable, the building was an approximate 8" out of level, functioning problems with interior doors, complaints from occupants, and a floor system that exceeded tolerance for localized deflection. This led to a decision that the drain system was functioning as intended, but that all the piers should be replaced. The owner hired S & W Foundation to undertake the pier replacement and with S & W President Tom Witherspoon designing the remedial foundation system.

New soil borings were ordered by S & W. These indicated that there was an active depth of 15' with uplift pressures of 2,000 psf and moisture contents that ranged from 11% to 22%. The zone from 15' to 25' showed to be a non-contributing section with allowable skin friction of 650 psf in compression and resistance against uplift of 550 psf. At 25' there is gray shale that was stable and provided not only anchorage against uplift but also significant bearing capacity.

Phase II was implemented by S & W Foundation. This consisted of replacing all piers with one to two piers per replaced pier. The new piers terminated into the gray shale.

Steel extended up from piers.

Excavating under the building.

Drilling under concrete beams.

The pier replacement area was accessed by excavating under the building with small rigs, relocating utilities where required and keeping the building operational at all times. The piers were 18" diameter, 35' deep from the paving surface and penetrated 10' into gray shale with an average SPT of 100/1.

Additional considerations included that there would be: no disruption to hotel operations, there would be a carpenter present on site during floor elevation adjustment, lawn sprinklers were to be kept in operation, an electrical system would be installed in a crawl space, small rigs with catalytic converters would be used to lessen emissions in order to maintain a ventilation system to provide safe air. Work was to begin at 8:00 am without excessive noise until 9:00 am, completing the day's work at 5:30 pm. The work commitment was for 6 days per week; conducting topographic surveys under the floor and inside the building before and during elevation adjustment; having steel reinforcing drilled into existing beams connected to pier steel, using sonotube forms from pier tops to floor beams and/or grade beams; conducting an independent inspection of all pier drilling, handling all steel and concrete placement; conduct-concrete cylinder tests of each pour; coordinating with hotel staff and owner representative during all operations; managing the installation of under floor sumps and drain lines, and replacing the soil under the building when complete in order to reduce the chance of standing water.

In order to access the work area, given the number of people occupying this hotel, it was important to install security fencing with ramps at two sides of the building. It was also mandatory that pier spoil and removed soil be hauled off site so that there would be no dirt left on the paved areas.

The following photo shows the very tight quarters and the Bobcat MT. It is so small that the operator must walk behind the machine. Four of these rigs were utilized on the job for performing the exca-

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Concrete placement.

Main access route.

vation in preparation for drilling operations. The idea was to access the work site through a center excavated hallway and then branch off between the lines of piers. This was done in order to provide ground clearance for drilling. Upon completion of the piers and adjustment of the floor elevation, soil was returned to the excavated space in order to prevent creating a bathtub that would hold water that might migrate into the crawl space.

As shown in the photo that follows, these piers were drilled under grade beams with as little as 5' clearance. All piers were, however, 18" diameter and over 30' deep including the 10' of shale penetration.

As shown in the photo that follows, these piers were drilled under grade beams with as little as 5' clearance. All piers were, however, 18" diameter and over 30' deep including the 10' of shale penetration.

Reinforcing steel diameter was kept to ¾" in order to reduce the lap, which in these tight quarters would have greatly increased steel cost. The laps were necessary in order to set the steel in short sections. This resulted in increased fabrication time prior to pouring concrete.

Concrete was amassed at the outside of the building using motorized buggies and transported to each pier for placement. This required sequencing of all movement under the building since there were several operations going on during the placing of pier steel. Proper lighting and directions created a safe work site.

As would be expected, power, sewer, water and communication utilities were in large supply under the building. This required excavation and drilling operations to be carefully executed not only due to safety concerns, but because any break in these lines might shut down the entire hotel. The only damage to piping that occurred in the almost 20 months of operation was caused by the impact of a Bobcat that ruptured a sanitary sewer line. Since flushing of toilets could not be stopped, the workmen repaired this line quickly. It never happened again.

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When a section of piers was completed, it was necessary to install jacks between beams and pier tops, cut away the existing piers that were being replaced by the remedial piers, and smooth the top so that a screw jack could be installed between the existing pier and beam (wood, concrete and steel beams). Using the remedial piers, the building in each section was adjusted vertically to meet the topography goal. The screw jack was then adjusted on the existing piers so that jacks on the remedial piers could be removed and the formed section could then be poured between new piers and building beams.

The method that worked best for cutting away the existing piers was drilling a

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Concentration of utilities.

Spreader bar breaking existing pier.

pilot hole into the pier, setting a spreader bar and expanding to rupture the concrete. This saved a considerable amount of time. The photo above shows how the spreader broke the pier.

Connection from the new piers to existing beams consisted of drilling into the beams, installing dowels secured with epoxy in the drilled holes at the concrete beam interface. The section from new pier to existing beam was then formed and poured with Siki-Quick 1000, which had a 15 minute set time. At the juncture of the wood and steel beams, it was necessary to install "J" bolts to attach to the beam and secure them laterally and vertically.

Screw jack set in place.

Adjustment of the building had to be scheduled with building management to not only have a carpenter on site to adjust doors to each room, but also to provide necessary security personnel to secure valuables of each hotel occupant. It was also important to produce on-going surveys of the floor so that elevation targets could be revised in line with feasibility assessments. Reaction of the building structure to lifting or lowering of an area required several amendments in topography goals. In that building management was directly involved in each adjustment, there was agreement regarding final positioning.

It was decided to not undertake lifts at the elevations in that any change in elevation might cause alignment problems that would compromise hotel operations. There was also one area where the concentration of utilities was so great that we could not install piers without the complete rerouting of these lines. This would have shut down hotel operations. When presented with the circumstances, and with management's on-site inspection of actual conditions, the decision to omit these areas became an economic determination that was embraced by all.

As a result of copious planning, flexibility during the project and a partnering attitude with management, the project produced a building where localized deflection was reduced to a functional level and hotel operations were never compromised. After completion of remedial underpinning, the perimeter French drain was restored in order to capture lateral moisture migration. As an added protection, drainage was installed in the crawl space even though soil was replaced so as to prevent ponding.

Pier cap poured under beam.

Finished pier columns up under foundation.

The final step involved restoring the perimeter landscaping to its original luster. All irrigation features were repaired to provide continued aesthetic appeal. The end result was a successfully constructed product that meets the owner's objectives. ■

LIMITED ACCESS SUCCESS

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