

Haiti

The Country That Time Has Left Behind

By Craig E. Barnes, P.E. SECB

Following the January 12, 2010, earthquake, Management Sciences for Health (MSH) engaged Haitian consultants to observe and report on the condition of MSH leased properties in Haiti. MSH subsequently approached CBI Consulting Inc. (CBI) to review and comment on reports prepared by these Haitian consultants, with the expectation that CBI would be able to use them to conduct an engineering review of various leased properties, damaged and undamaged, and determine whether the buildings were safe for habitation.

The first report revealed numerous obstacles. There were no plans for the buildings, descriptions of the construction, engineering calculations, or overall pre-quake photographs enabling a reviewer to determine whether it was a one story or taller building. The reports contained no assessment for habitability and any recommendations for repair were extremely modest, such as simply patching of cracks in masonry construction with mortar. Telephone conversations with the consultants, from over a thousand miles away, revealed that the information CBI needed would not be forthcoming. That resulted in a contract between CBI and MSH to send the author to Haiti to review the situation firsthand.

At CBI's urging, and before the author departed for Haiti, the client engaged a geotechnical engineer to approximate the location of the building sites with respect to the seismic epicenter and the soils profiles that might be encountered at the various sites. Of the thirteen sites that were evaluated, the closest was approximately seven miles from the epicenter and the most distant was approximately 17.5 miles away. The soil bearing characteristics ranged from alluvium soil to ledge.

Observations on Arrival

On arrival in Port-au-Prince, it was obvious from the chaos that this would be an unusual undertaking. The ride from the airport to the headquarters office of the client was along streets lined with damaged



Residential Area.

buildings and individuals selling fruits, vegetables, roadside prepared foods, and a variety of retail items. Without the order, it was somewhat like walking down a poorly kept aisle of a retail/grocery store with broken shelves. The first meeting with the client revealed that there was a very poor understanding of earthquake issues and the work of structural engineers.

The client's expectations were the same as had been discussed before the author arrived in Haiti: to provide comfort and assurance to residents and employee occupants of various buildings that it was safe to return. Initially, the client did not understand that the request was an impossible order given the limited information available; that an engineer could not simply view a structure and determine the structural sufficiency, let alone how it would perform in an undefined future earthquake.

To prepare a way to manage expectations and outline a reasonable objective, the first full day in Haiti was spent simply touring and photographing as many of the structures as possible. That day revealed a range of buildings with conditions from total collapse to no observable damage. Although the scope had clearly been revised in the mind of the author, the client was not yet on board. The second day on site would not be the appropriate time to attempt explaining the realities to the client. The process had to be one of gradual education.

Building Inventory

The subject structures were from one to five stories in height and had plan areas between 1,500 and 10,000 square feet. With few exceptions, buildings had reinforced concrete columns infilled with unreinforced masonry supporting cast-in-place concrete floors/roofs. One exception was a building of one level that had unreinforced masonry bearing walls with no concrete columns, supporting a roof of open web steel joists and plywood. Another exception was a three-story warehouse building with a roof structure of open web steel joists that formed a seven-foot-deep hip roof and supported a metal deck. All buildings were presumed to have concrete spread footings under columns, and strip footings under walls. Slabs on grade are reinforced or unreinforced concrete.

Commercial versus Residential Construction

Following a review of the structures with which CBI would be involved, and viewing other construction operations observed in the immediate vicinity, it was obvious that there were two types of construction, commercial and residential. Commercial construction includes those



Mixing Concrete.

buildings that utilized carpenter-built concrete forms, ironworker-placed column reinforcing steel, and apparently increased attentiveness on the part of concrete placing crews. Projects of residential character appear to have been constructed more haphazardly, with much less concern for placement of reinforcement, construction of concrete forms, and concrete placement techniques. With the exception of a large warehouse facility and a medical clinic, all the buildings that the author observed were currently or formerly residences. Many of the structures were built in the colonial period, and had been occupied by command or military personnel or upper echelon government individuals. In recent years, many of these buildings were simply renamed as either an office building or warehouse. One warehouse facility started as an upscale residence of four stories, with setbacks at two floors where additional light frame construction was infilled. The infill work was poorly constructed and may have been done in anticipation of the marketplace that required warehousing.

It was apparent that ground movement from site to site, as well as the response of structures to ground movement, had not been the same. Similarly constructed buildings in close proximity responded differently to the seismic disturbance. The fact that buildings on the same foundation material behaved differently during the earthquake suggested that construction sufficiency was an important element of performance. The fact that buildings with similar construction deficiencies behaved differently during the earthquake suggested a difference in the ground movement itself.

Some of the grander residential structures had open areas at the first floor. Upper floors were enclosed in masonry and concrete construction. The vulnerability of soft stories was clearly demonstrated in these cases. In general, discontinuity in load path, absence of reinforcement in concrete masonry walls, and poor construction practice were frequent contributors to distress.

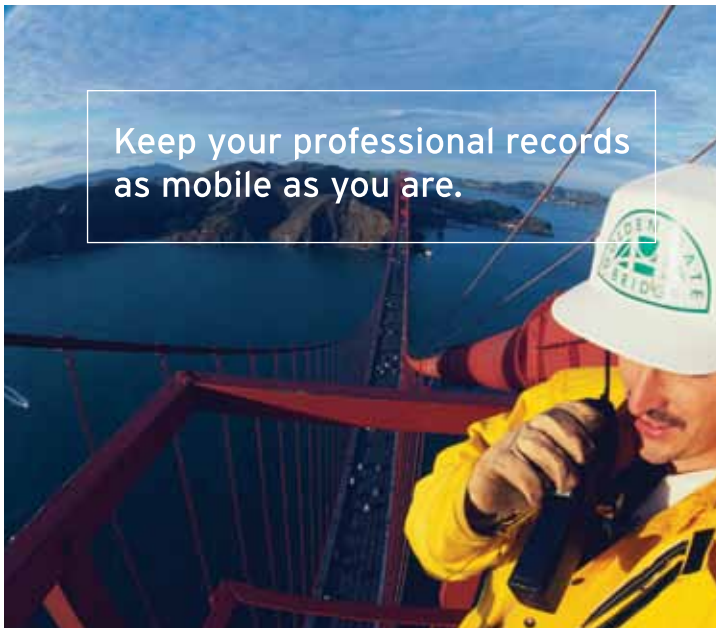


Pouring a Concrete Column Between CMU Walls.

Cracks in finished wall surfaces – for example, 1/2-inch cementitious stucco and plaster applied to the concrete and CMU frame – were evidence of deficiencies in the construction and/or lack of reinforcement.

The author did not meet and talk with engineers that were experienced in commercial construction, but at the residential level there seems to be very little engineering that takes place in the average structure. Haitian architects and engineers seem to do what has worked well in the past and has been passed down through the years. The individual with

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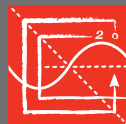
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Rare Example of Slope Instability.

whom the author interfaced primarily was a graduate of the University of Haiti where he had taken courses in engineering and architecture. Although having graduated, there was no degree conferred and there was no registration process at a governmental level to attest to his area of expertise.

This architect/engineer would prepare contract documents using traditional spans, heights and member cross sections, and then rely on the contractor to provide the reinforcement. There are no codes mandated in Haiti, and as a result, no specification of gravity or lateral loads for design. Even in the warehouse projects, there was no understanding on the part of the lessee regarding the capacities of the floor systems. It appeared that those elevated structures were not loaded beyond 60 to 70 pounds per square foot, which was consistent with the author's estimate of capacity.

Education

Given the governmental instability of Haiti, it appears as though, in the near term and perhaps in the long term for that matter, repairs to existing facilities and new construction will be the product of the Haitian engineers and architects, and local contractors. Would it be a major step ahead to employ outside design, engineering and construction expertise? Absolutely, but the bureaucracy is not currently structured to accept such assistance. If there were a way to move the bureaucratic bottleneck (local government) aside, then major strides could be made quickly. However, working within the current system to introduce education and expertise from outside the country would improve the situation. When one observes, in the rebuilding effort, repetition of the same deficiencies that exacerbated the distress to structures being repeated, it is obvious that there is a major disconnect. Poor design begets poor design, poor construction begets poor construction, and in this process the quality bar for both trades is lowered without those trades themselves understanding the rut into which they have fallen.

Construction

In one telling conversation with a local contractor experienced in both residential and commercial construction, the author came to understand the frustration. This contractor had participated over a period of more than five years in some rather sophisticated wastewater treatment construction in Florida, and then moved his operation to Haiti when it appeared several years ago that political stability had returned and new markets were opening. However, none of that growth took place, and the contractor needed to make his living competing with local Haitian construction activities. That competition, unfortunately, led him to take shortcuts and rely on local labor and materials that resulted in a product that he knew was not even close to the quality that would have



Typical Rib/Beam Slab Before Concrete Placement.

been required in Florida. He freely admitted that it took approximately five years for his company to reduce the quality that they wanted to put into a project, to the level that it is today.

When concrete is mixed on the ground from a cleared area with laborers using estimates of quantities, and when concrete is transported in five gallon buckets to literally *pour* a column, it is easy to see that the construction process can be significantly improved. When designers and contractors understand the benefit of placing reinforcement through joints and from the foundation through the vertical height of a building, and those designers and contractors have pride through the quality control process to affect the quality of construction, then the process will improve. Port-au-Prince and the surrounding hills are loaded with similarly deficient construction just waiting to collapse with the next major earthquake. Short of complete demolition and reconstruction, many of these structures would be made more robust using techniques that are readily available throughout the developed world but are not currently available in Haiti.

Epilogue

Haiti suffers decay brought on by years of government mismanagement and corruption. As one contractor paraphrased very succinctly, regarding government, contracting entities, and business entities, "Everybody is *looking, looking, looking.*" In other words, with those three words the contractor was saying that the three major groups that could be instrumental in rejuvenating Haiti are looking at each other to see how they can line their pockets with the aid money that has been pledged for the reconstruction. This is both tragic and shocking, but as one looks about the country, the results can be observed everywhere. Bad behavior at the governmental level will not be changed overnight, but perhaps there is a way to marginalize that segment so that design professionals and contractors can work cooperatively. It has become apparent that neither side is happy with the status quo. They know that they can do better, and many of them want to do better. Grassroots efforts, professional organizations, and contractor organizations are low-cost ways to begin changing the process.

Hopefully, former President Clinton's recent efforts to remind donor nations of their pledges for reconstruction will begin to change the dynamics. How can professionals assist in that effort? Your comments will be appreciated. ■

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