Use of Shrinkage-Compensating Cement in the Ridgecrest South Residential Community Building
University of Alabama Campus
Tuscaloosa, Alabama

by
Kenneth B. Bondy
Structural Engineer

This will summarize my observations and opinions regarding the Ridgecrest South Residential Community Building on the campus of the University of Alabama in Tuscaloosa.

BUILDING DESCRIPTION

The building is an 8-story student dormitory and parking structure for the University of Alabama. All of the floors are framed with cast-in-place post-tensioned flat plates (solid thickness slabs supported on concrete columns with no drop panels or shear caps). The lower three elevated slabs are roughly 650'x300' in plan dimension, separated by a central permanent expansion joint running in the 300' dimension. The slab-on-ground and the first two elevated decks are used for parking; the third elevated deck is the first residential floor and forms two large courtyard areas with landscaping. The upper 5 residential slabs (including the roof) are C-shaped, back to back in the center of the footprint, with plan area much smaller than the lower footprint, and form the two large courtyards at the third floor. The lower three elevated slabs are 7-1/4" thick; the third floor slab is 12" thick under the residences, with a one-inch step down at the perimeter of the residences to an 11" thick slab which slopes at the top to courtyard drains. The upper residential slabs are 7-1/4" thick. Type K cement was used in the lower three slabs but not in the upper residential slabs where Type 1 was used (with pourstrips). At the time I was onsite in April of 2009 the building was structurally complete but finish work was still underway. Following is a small plot plan taken from the structural drawings which shows the orientation of the residential slabs with the lower parking slabs:

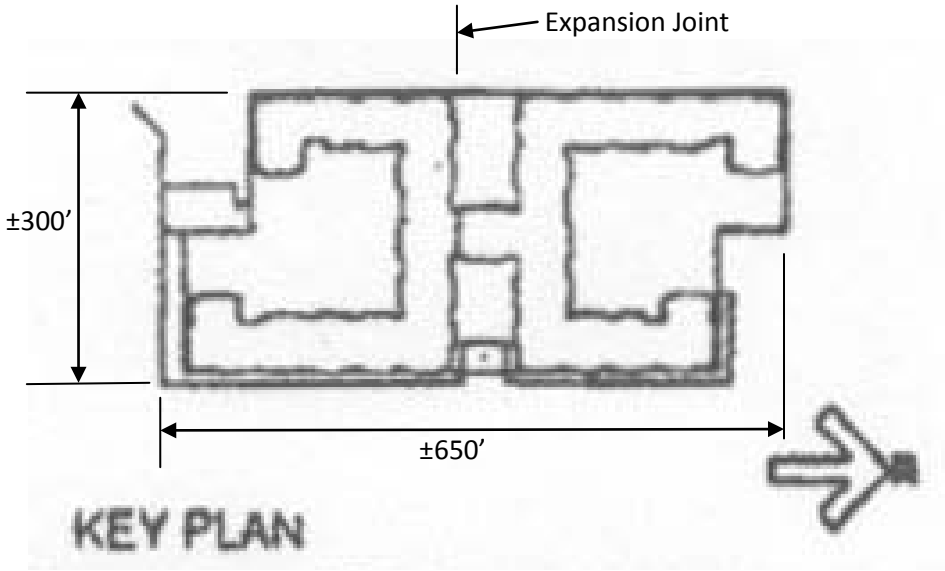

Figure 1 – Plot Plan

Following is a photograph of the north exterior elevation:

Figure 2 – North Elevation Showing Three Lower Parking Levels and Five Upper Residential Levels

HISTORY

Originally the building was designed with light steel framing in the upper residential floors. The bearing walls were supported on the third floor concrete deck on a grid of deep concrete transfer beams with a post-tensioned slab outside and between the beams. The lower two elevated parking slabs were post-tensioned flat plates with a central expansion joint separating the slabs into two pieces, each roughly 300'x300' in plan dimension. Each 300'x300' piece was divided by pourstrips into four smaller pieces. The pourstrips were to be kept open for 9-12 weeks after stressing.

The job was bid and came in substantially over the ±$70 million budget. The structural engineers, Structural Design Group (SDG) in Birmingham, proposed two significant changes involving the post-tensioned slabs, first to eliminate the steel framing and use post-tensioned concrete slabs in the upper residential floors, with the same column layout as below. That would eliminate the grid of transfer beams at the third level. Next, they proposed elimination of the pourstrips in the lower three elevated slabs, accomplishing this with the use of Type K cement. This would offer direct savings in the cost of constructing the pourstrips, and significant savings in time. SDG was authorized to do a complete redesign of the building based on these and other cost-saving measures.

The job bid a second time, and was under budget. The structural engineer reported that the net savings realized by eliminating the pourstrips was approximately $250,000, including the premium for the Type K cement. The total savings realized by the redesign was about $3 million.

The elimination of the pourstrips, and all the resulting savings from that, could not have been done without the use of Type K cement. The slabs were instrumented by Dr. Jim Richardson, a professor of Civil Engineering at the University of Alabama, who will publish his results in a forthcoming journal paper.

BUILDING INSPECTION

I made a detailed inspection of the interior (the garage slab levels) and much of the exterior of the building in early April of 2009. Based upon that inspection I can report that the slabs are in excellent condition. I observed the far corners of each of the sections separated by the expansion joint and could see no cracking related to restraint-to-shortening. The only cracking I saw consisted of several very small (hairline, 4-6" long) cracks at the soffit of the slab where it met the corner of a column at one extreme corner of the footprint, and two short hairline cracks on the top slab surface of the third floor in the center of one of the courtyard areas. Both of these crack conditions are likely to be surficial plastic shrinkage cracks only, not related to overall volume change or restraint to shortening. Any experienced observer of post-tensioned slabs would rate the performance and condition of these large slabs as outstanding, most would describe the slabs as "crack-free". The excellent slab performance is even more striking considering the fact that they had plan dimensions of more than 300 ft. in both directions and were constructed ***without*** pourstrips. Following are several photographs

showing the framing and the soffit of the first level slab, the level most sensitive to restraint-to-shortening cracking, taken while standing on the slab-on-ground:

Figure 4 – Soffit of First Level Slab (Standing on Slab-on-Ground) Looking West and North

Figure 5 – First Level Slab-Column Joint Looking West

SUMMARY AND RECOMMENDATIONS

This is a very important building. Its significance cannot be overestimated. It could establish a relationship between post-tensioned concrete and shrinkage-compensating cement that will have a great impact on future design and construction practices. Things were done in this building that could not have been done without the use of Type K cement, and they resulted in outstanding performance and significant cost savings. The performance of this building suggests that, with the use of Type K cement, the typically accepted spacing of pour strips and expansion joints can be significantly increased, resulting in considerable savings in cost and construction time.