The Wrong Kind of Sandwich

by Prof. Ysrael A. Seinuk, P.E., CEng, FACI, FICE, FASCE

Architecture and economy demand that in tall structures, higher strength concrete be used in the columns. The slab system can perform perfectly with lesser strengths, hence "the Sandwich" - that part of the slab compressed by the columns.

According to a project's geographic location, the "Slab" can be beam and slabs, flat slabs, flat plates...etc., and the location will influence how the sandwich issue is addressed.

The practice of placing concrete with the same strength as that of the columns, in an area surrounding the column – the "Glob" – is popularly used in locales where the lowest possible slab strength is the economical approach. Another method is to place the whole slab with a strength that, while not required, avoids the use of two concrete mixes, a procedure that requires more attention and may slow down the placement of concrete.

Several codes address what should be the ratio of strength of the column concrete to that of the slab, and several alternative procedures are suggested on how to deal with this situation. Because of its confinement by the rest of the slab, the concrete in the sandwich is assumed to be able to carry stresses higher than its specified strength. For instance, the ACI code permits a ratio of strength of column to slab of 1.4. In the event that this ratio is higher, then an effective concrete strength for the column concrete is considered to be the addition of 75% of the column strength to 35% of that of the slab. The latter has been challenged as unconservative.

The unique New York combination of flat plate buildings, together with the "two-day" cycle, imposes the need for impeccable teamwork by construction managers, erectors, suppliers and the inspection group.

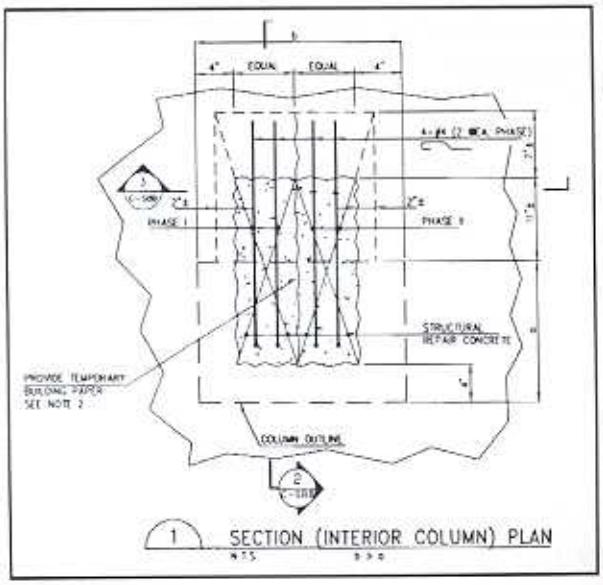
It is interesting to point out that, albeit uncommon, a three-slab-per-week cycle has been successfully achieved in New York.

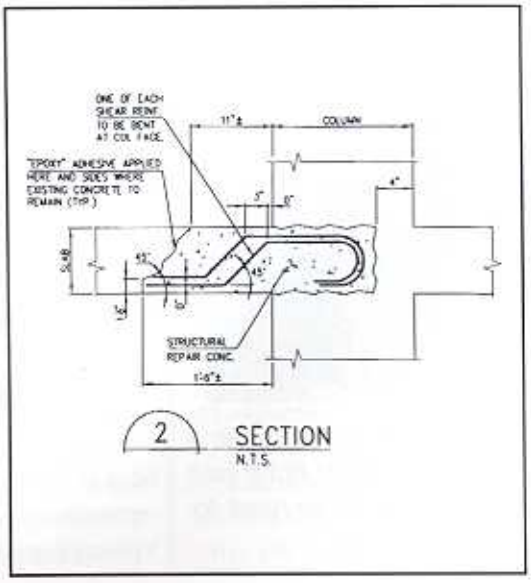
Riverside South

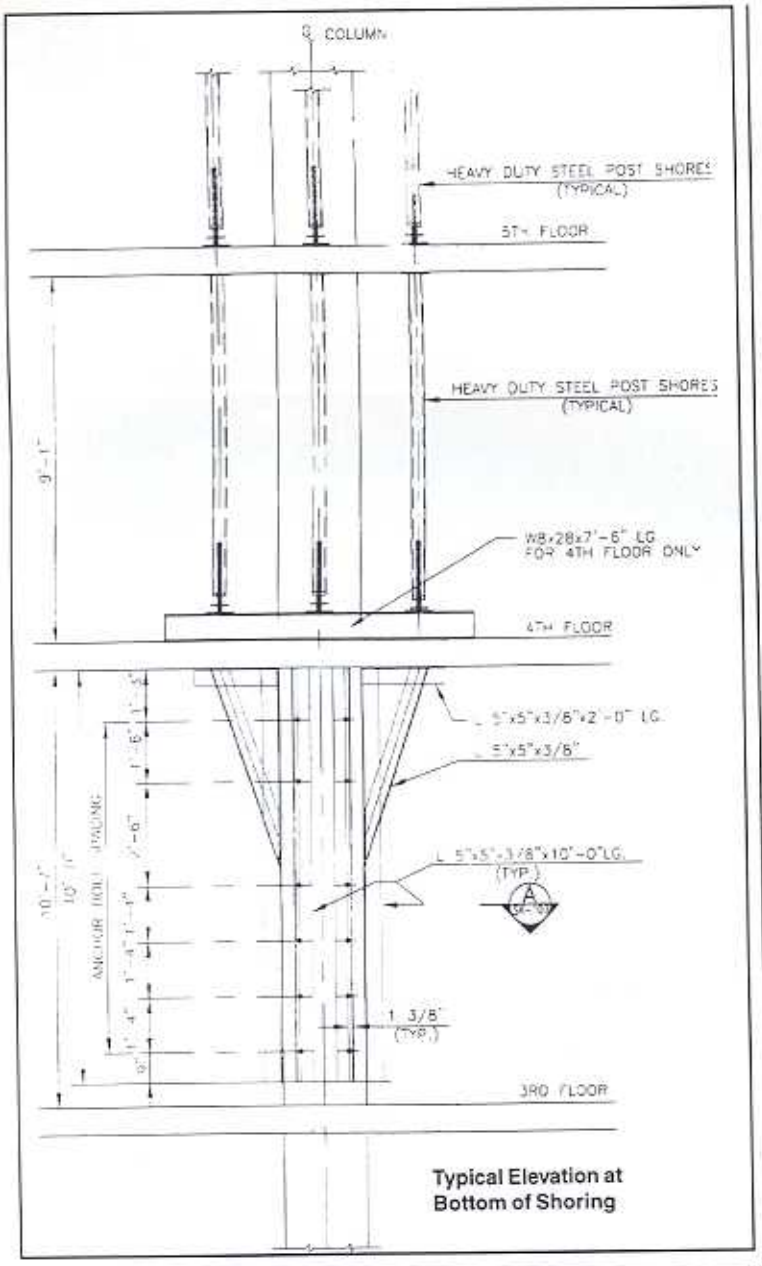
A glitch in that teamwork occurred at the 5th floor of Building "C" at the Riverside South project, a situation where a group of column sandwiches did not attain the required strength. As this is written, the situation has been satisfactorily corrected. The columns above and below the fifth floor required 7,000 psi concrete, the sandwich required 5,000 psi, while the rest of the slab required a lesser strength. The contractor opted to pour the entire slab with 5,000 psi.

The repair procedure for the sandwich concrete was as shown in sketches 1, 2 and 3, and with shoring required as shown.

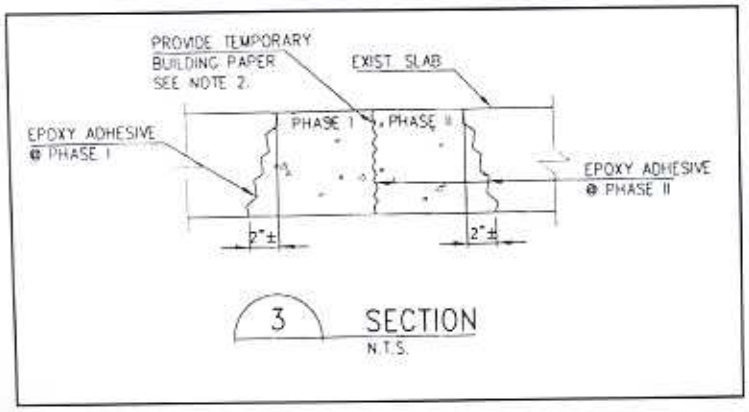
In order to cause the least disruption by the repair, the decision was made to allow a U-shaped portion of the original sandwich to remain. This contained all, or most, of the column reinforcement. Thus, there is minimal effect on the existing column reinforcement, the slab is well supported, and there is partial resistance to the existing vertical







Typical Elevation at Bottom of Shoring



loads. The ultimate behavior of the sandwich is also enhanced by having most of the reinforcement contributing in the remaining weaker concrete portion.

The material Eucocrete, by Euclid Chemical Company, which was used to infill the sandwich, is capable of achieving strengths of over 4,000, 6,000 and 8,000 psi at three, seven and 28 days respectively. Several tests from field samples showed results over 10,000 psi at 28 days. The procedure was performed under strict supervision, not only for the shoring, drilling and placing of the material, but also for monitoring the temperature closely.

On January 15, 1998, the New York City Buildings Department lifted the stop-work order that had been imposed last fall and the erection of the tower resumed. ■

About the Author: *Ysrael A. Seinuk is the Chief Executive Officer of Ysrael A. Seinuk, P.C. In addition to his engineering practice, he is Professor of Architecture and Chairman of the Structural Department at the Cooper Union's School of Architecture. His firm received the CIB's Annual Award in 1996.*

Some Mix Design Seconds

- *Concrete strength is reduced about 5% for each percent of increased air entrainment.*
- *Air entrained concrete requires less mixing water for a given slump because the air bubbles lubricate the mixture.*