Superstructure Completed in Just Eight Weeks

By Peter A. Naccarato, P.E.

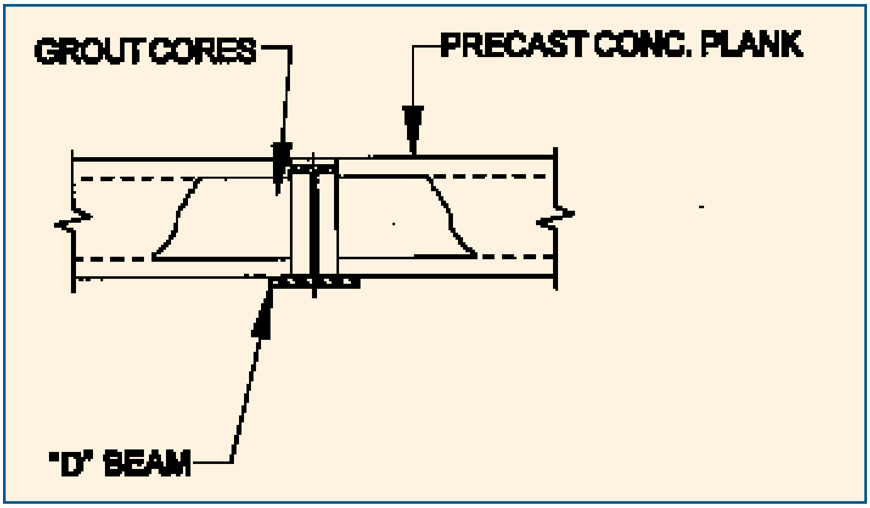
Recently, Drexel University, Philadelphia's prestigious technological school, found itself in the precarious position of having three hundred and fifteen incoming freshmen that had all been promised on-site dormitory space for the September 2000 semester. It was already October of 1999, and the University was in the midst of a scheduling dilemma-with less than a year to go they had a complete set of plans for the dormitory ready for bids but nothing else. They found their answer in structural steel.

The University called for a structural system of precast hollow core slabs supported by masonry bearing walls. The construction staff, headed by Marc-Antoine Lonbardini, director of planning design and construction and Douglas M. Aitken, associate director of planning design and construction, did not hold out much hope for delivering this building on time. Since a pile foundation had to be installed first, there was little hope that construction on the superstructure could begin before December. Adding further difficultly was the fact that a winter start would penalize the masonry bearing wall schedule.

The University solicited bids based on the bearing wall plans, but requested that the contractors submit suggestions on alternate systems that could guarantee the opening date. P. Agnes Construction Company of Philadelphia provided an alternate bid based on the patented Flex-Frame Precast and Steel, a system which had already proven its ability to be constructed quickly through almost any weather. Subsequently, their bid also proved that the steel system direct cost was less than the direct cost of the bearing wall structure. This was due, in part, to the fact that the masonry walls had to be heavily reinforced to satisfy seismic requirements.

After being awarded the project, P. Agnes commissioned a redesign of


Week One
Week Two
Week Three
Week Four
Week Five
Week Six
Week Seven
Week Eight



Schematic of Flex-Frame beam and plank.

the structure utilizing the services of Burt, Hill Kosar Rittleman Associates, the original project architect. They retained O'Donnell & Naccarato as structural engineers. O'Donnell & Naccarato worked with Flex-Frame in developing their system and provided the structural engineering for Agnes' Casa Farnese project.

So what exactly is Flex-Frame? Ever since the 1993 revision to the BOCA Seismic Section, the block bearing wall type of construction has begun a slow demise. The revision created three distinct disadvantages:

- Lateral loads increased;
- Lateral loads were equal in all directions; and
- Reinforcement of the masonry walls was mandatory.

For more than 40 years, Costanza Contracting Company, a General Contractor, AISC-member Fisher Steel, Inc., a Structural Steel Fabricator, and O'Donnell & Naccarato Inc. have been active in design, fabrication and construction. Among their projects have been millions of square feet of plank and bearing wall buildings for apartment houses, hotels, condos and adult living, retirement and nursing homes-structures with bearing walls up to 10-stories in height and little or no steel wall reinforcement.

Also, since wind was the governing lateral load on these low- to mid-rise structures, the demising walls, which acted as bearing walls, functioned as shear walls to resist lateral loading at no additional cost. As a result of the BOCA revisions, the trio of forms joined to start a new company called Flex-Frame L.L.C.

Flex-Frame's sole purpose is to set about perfecting a steel and plank design-a design that can take the place of the plank and bearing wall system. Knowing that the primary alternative to plank and bearing wall is cast-in-place flat plate construction (the most expensive structural system in the Philadelphia area), the new company designed and built several residential buildings with the use of conventional structural steel and prestressed precast plank. Unfortunately, this system had both pros and cons. The advantage was its low cost when compared to cast-in-place flat plate construction; the disadvantage was that the rolled steel shapes beneath the floor slab necessitated an increase in the floor-to-floor height, resulting in an increased height of 2'-0" per floor. Also, ceilings and soffits were needed to conceal the steel beams, and holes had to be cut through the beam webs to accommodate pipes and ducts.

In order to solve the floor-to-floor and interference problems, Flex-Frame implemented a research and development program. It wanted a system where the interior structural steel girder could be placed within the plane of the precast plank, thereby producing a flat plate system with a floor-to-ceiling height of 8'-0". The key to the system would be the development of a unique steel section, which could provide the plank support with only an 8" depth while spanning a respectable distance. If the system could be designed and fabricated to provide interlocking, the appropriate steel shape could develop composite action with the precast plank and cast-in-place grout.

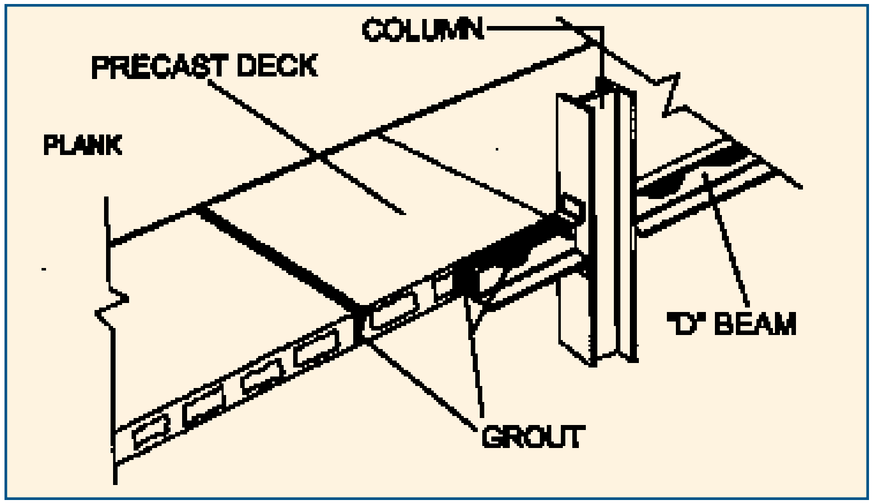
During the installation of the pile foundations for the new Drexel dormitory, the superstructure was completely redesigned by O'Donnell and Naccarato with Strescon Industries and Fisher Steel Corporation providing design input. All of the superstructure materials were ready for installation by the end of foundation construction. The first column was set on January 10, 2000, and the final hollow core slab was placed on February 28, 2000. The entire super structure was erected in 31 working days, few of which achieved an above freezing temperature.

Still, there were problems due to the weather. For instance, the superstructure erector, J. L. Erectors of Blackwood, NJ, was concerned because the below freezing temperatures prevented the grout installation. The portland cement grout is the component material, which provides the integral connection required for diaphragm action for the completed structure. In conjunction with O'Donnell & Naccarato, J. L. developed an erection technique wherein all connections were fully tightened as each floor was erected. This included the permanent lateral load resistance systems. The lateral restraint in the short direction consisted of cross bracing and in the long direction rigid moment frames. All of these connections were fully tightened and since the building required no temporary heat, there were no temporary exterior walls that could transfer wind load into the diaphragm. The building was fully grouted shortly after the topping out.

As of July 24, 2000 the project was on schedule and a September 15, 2000 occupancy is expected. Not only did the project prove that structural steel can be used effectively in multi-family residential construction, but it provided an economical, rapid and low floor-to-floor building that was built quickly under cold weather conditions.

Peter A. Naccarato, P.E. is Principal of O'Donnell & Naccarato located in Philadelphia, PA.

Flex-Frame is a Cherry Hill, NJ based company that can be visited at their web site www.flexframe.com.



Schematic of Flex-Frame system.