SHRINKAGE-COMPENSATING CONCRETE MAKES NEW HIGH-TECH 10-STORY WAREHOUSE A REALITY

Fig. 1 – The low bay has a typical clearance height of 30 feet but the high bay is 115 feet tall, which is a remarkable 10 stories.

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Only the sky appears to be the limit for Orlando-based Nephron Pharmaceuticals Corp. The generic respiratory medicine company is nearing completion of a new fast-track (humorously referred to as "blast-track" at the jobsite) addition to their existing 30,750-square-foot precast double-tee warehouse. The addition has a new 14,900-square-foot low bay warehouse for typical warehouse operations and a new 210,000- square-foot high bay warehouse with an Automated Storage and Retrieval System (ASRS) structure that will house millions of vials of medicine. What do these two different warehouses require in terms of height? The low bay has a typical clearance height of 30 feet but the high bay is 115 feet tall, which is a remarkable 10 stories. Most warehouses are only two to three stories tall, but this ASRS warehouse needs the height to function at its best. The high bay is being built for a different type of storage. Nephron will use mechanical cranes and steel racks to store and retrieve pallets of Nephron's manufacturing materials and products on and from the upper levels of the computer-controlled warehouse. This new design will have a substantial effect on Nephron's operations – they will be able to store 10 times more product per square foot than a traditional storage facility.

To accomplish this construction feat requires special construction, engineering and materials. The High Bay ASRS building is a "rack supported" structure, whereby the racking system is load-bearing and not only supports the dead and live gravity loads, but also resists the lateral wind loads. An extremely tight tolerance of L/2000 was specified by the manufacturer for the allowable settlement and deflection of the foundation system, so it was determined that a pile supported mat slab was the optimal foundation to support the superstructure. "This project has been an extremely challenging building design," said Daniel Silvestre, President, Silvestre Engineering. "Blending together, European, German and American standards, codes and norms for this type of building, took a huge effort and real team work. From the ownership to the design team to the builder, everyone worked very hard to achieve the project's goals."

"We had to meet requirements of the current Florida Building Code, ASCE 07, AISC, AISI, ASTM, FEM (Federation Europeenne de la Manutention), current DIN norms, etc.," said Silvestre. "The high bay warehouse racking system was originally drawn and calculated under European and German standards. We had to convert all

Fig. 2 – The foundation consists of a mat slab that is 102-feet by 206-feet and 32 inches thick.

that information into U.S. standards and codes. There were numerous calculations, reviews and analyses done prior to breaking ground."

Construction of the high bay began with installation of the 535 piles, which were completed in only 16 days. The mat slab concrete placement came next and was scheduled to begin at 9:00 p.m., due to the cooler temperatures and to avoid the frequent afternoon rain showers that Central Florida experiences during the summer months. Although there were heavy showers in the afternoon on the day of the pour, the skies cleared a few hours before the start and continued to be clear throughout the night and into the next morning, as the pour was being completed. Maturity sensors were placed in the slab that provided early indications that the specified 28 day compressive strength was going to be easily achieved and provided the necessary data to determine when the crane could crawl up on the slab so the erection process could begin.

Building such a specialized structure called for a unique material to be used in the construction of the foundation. The foundation consists of a mat slab that is 102-feet by 206-feet and 32 inches thick. This slab was placed on 535 augercast piles and was tied to the piles with reinforcing extending out of the piles and hooked into the slab. The reinforcing of the slab consisted of #6 bars at 9 inches on center each way top and bottom. The engineer's main concern was that there could be no control or construction joints in the slab. To achieve this, the engineer chose CTS Cement's Komponent. The Komponent system is a method for making a Shrinkage-Compensating Concrete (SCC). The Komponent system when mixing 85 percent portland cement and 15 percent Komponent at the batch will make a ASTM C 845.

Type K expansive cement that is used to make SCC. According to the American Concrete Institute (ACI) committee report 223R-10 "Guide for the Use of Shrinkage-Compensating Concrete," Type K expansive cement when mixed with water will increase in volume. This increase in volume will decrease when the water of convenience is gone. This volume increase in the concrete will induce tensile stress into the reinforcing steel putting the concrete into compression. Keeping concrete in compression during the early stage of curing will minimize the shrinkage cracking, which is not the case when using portland cement concrete. This was proven in this project as the finished slab has no cracking, no control joints or construction jointing.

The outcome of using Type K shrinkage-compensating cement was that the 102-foot by 206-foot slab is crack free and has a dense and durable surface.

The new warehouse facility will join the current 200,000 square feet housed in six existing buildings, all within the same area. These facilities include production and packaging, warehouse space, scientific labs, sales, marketing and administration. When the new warehouse is complete, the Nephron facility will operate 24 hours a day in two 12-hour shifts.

The project team included General Contractor, J Raymond Construction Corporation, Architect, Associated Consulting International, Inc., and Structural Engineers: BBM Structural Engineers, Inc. (SEOR) and Silvestre Engineering, Inc. (High Bay Specialty Engineer).

REFERENCES

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