CASE STUDY: How Comal County Saved Local Taxpayers Nearly $1M

COMAL COUNTY NEW JAIL FOUNDATION DESIGN AND COST CASE STUDY

In November 2015, Comal County residents approved the issuance of $76 million in bonds to build a new county jail and renovate the existing Walter Fellers Law Enforcement Center. The new jail will be located in New Braunfels, Texas, and will hold 565 general-population inmates plus an additional 18 infirmary and mental health beds for 583 total beds, with room to expand to 900 inmates. Housing options include a wide variety of custody levels, including separation cells, single cells, double-occupancy cells, quad cells, and open dormitories. Ground-breaking on the jail project occurred on Nov 29, 2017, with expectations of substantial completion in Fall 2019.

FOUNDATION DESIGN CHALLENGES

The design of the new jail foundation was challenging. The goal was to design a cost-effective and quality foundation system. The site for the new jail contains problematic active clay soils that will expand and contract like a sponge in response to changes in moisture content. The soils are expected to have vertical movements up to 6¼ inches. The foundation design needed to incorporate a concrete slab that can accommodate significant soil movement. Furthermore, the new jail superstructure and interior design needed to incorporate tilt-up wall panels, heavy concrete block (CMU) walls, interior structural steel support columns, prefabricated steel modular cell construction and extensive under-slab plumbing, electrical and security electronics conduits.

Two competing foundation designs were engineered and furnished to industry commercial concrete subcontractors for bidding purposes:

Plan A A traditional suspended slab on conventional drilled concrete piers using carton forms to create the under-slab void space.

Plan B A new innovative foundation design utilizing the SlabTek System that incorporates steel helical piers and steel lifting mechanisms allowing the slab to be poured on the ground and elevated to form the same under-slab void space indicated in Plan A.

Both the *Plan A and Plan B* foundation designs were bid and submitted to the Construction Manager-at-Risk (CMAR) firm, Yates-Sundt JV. On February 8, 2018, Comal County Commissioners Court approved the new jail GMP. This GMP approval allowed the concrete foundation package to be awarded to Urban Concrete Contractors of San Antonio, TX. The Plan B SlabTek foundation design described above was chosen as the foundation design of choice with an estimated **direct cost of work savings afforded to the Comal County taxpayers at nearly $900K.** Furthermore, the project team is working on additional value engineering savings opportunities to hopefully increase the SlabTek System's cost savings to $1 million overall.

WHY THE COST DIFFERENCE?

The SlabTek System's design is based on the principle of a larger number of lower-cost steel piers, placed closer together with a thinner lower-cost slab, resulting in the following cost savings, which are summarized below:

- 5" thick slab vs. 10" thick slab reduced concrete cost almost in half.
- Elimination of more than 350 very expensive 18" diameter drilled concrete piers.
- Reduced cost for the post-tension cable and rebar package.
- Elimination of cost and schedule risk with carton forms under the main slabs.
- Elimination of the need for expensive stud-rails.

TELLA FIRMA SYSTEM | THE BROADDUS COMPANIES | YATES CONSTRUCTION SUNDT | CHILDRESS ENGINEERING SERVICES | COMAL COUNTY TEXAS

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Architect's rendering of the new Comal County Jail

GEOTECHNICAL SOILS TEST RESULTS

A geotechnical engineering firm was hired to perform site soil borings and generate a geotechnical soils report. The geotechnical soils report indicated that the jail site is naturally underlain with the soils/rock of the Pecan Gap Chalk which weathers to form moderately deep soil and typically consists of clays, marly clays, and marly grading to chalk at depth. The subsurface stratigraphy at this site can generally be described as highly plastic dark brown clay overlying plastic to highly plastic, blocky, tan/tan and gray clay. **Key geotechnical engineering concerns for development supported on this formation are expansive, soil-related movement.**

EXPANSIVE SOIL-RELATED MOVEMENTS – 6-1/4 INCH PVR

The anticipated ground movements or Potential Vertical Rise (PVR) due to swelling of the underlying soils at the site were estimated at values ranging from 2-3/4 to 6-1/4 inches and with an active zone of 15 feet deep. The geotechnical engineer (Geotech) noted that actual movements can exceed the calculated PVR values due to isolated changes in moisture content (such as due to leaks, landscape watering) or if water seeps into the soils to greater depths than the assumed active zone depth due to deep trenching or excavations.

Diagram showing location of geotechnical borings

OVEREXCAVATION AND SELECT FILL REPLACEMENT OPTION

The first option that was considered was over excavation and select fill replacement. The Geotech indicated that at least 8 to 12 feet of fill replacement would be required to reduce the estimated PVR to 1 inch or less – the PVR requirement for the structure. Due to the depth and cost of over excavation / select fill, the geotechnical engineer recommended against this method.

STRUCTURALLY SUSPENDED FOUNDATION SUPPORTED ON PIERS RECOMMENDED

Instead, Geotech recommended that a structurally suspended foundation supported on drilled-and underreamed piers be utilized for the proposed structure. The Geotech specified that the drilled piers should be designed to a depth of 30 – 35 feet and noted that groundwater seepage was observed in the test borings and therefore recommended that the bid documents require the foundation contractor to specify unit costs for different lengths of casing that may be required.

REQUIREMENT TO SUSPEND THE GRADE BEAMS AND FLOOR SLABS

Geotech recommended that the grade beams and floors be structurally suspended creating a void space of at least 12” due to the anticipated ground movements. Areas containing critical entry/exit points to the building, such as doorways, should consider using a suspended system that is placed monolithically with the foundation to relieve those areas of heaving stresses caused by expansive soils.

PROBLEMS WITH CREATING THE VOID SPACE WITH CARTON FORMS

Geotech warned that when carton forms are used to form subfloor void spaces, the forms often get wet or sometimes absorb water from humid air. This can result in collapse of the forms during the placement of concrete, thus diminishing the design void space. Conversely, if the carton forms are too strong and do not decompose sufficiently with time, they may not collapse as soil heave occurs, resulting in heaving damage to the floor slab. For these reasons, Geotech **recommend that, where possible, consideration be given to methods other than the use of carton forms to form the recommended void space beneath floor slabs.**

TWO DESIGN OPTIONS: *PLAN A* and *PLAN B*

PLAN A DESIGN – HEAVY PIERS, HEAVY SLAB SUSPENDED WITH CARTON FORMS

In early 2016, the architecture and engineering firm decided to move forward with a preliminary design based upon many of Geotech's recommendations. The foundation would contain drilled shaft piers with a 10" thick suspended slab, which are temporarily suspended with 12" thick carton forms**.** The slab would be reinforced with post tension cables and rebar.

PLAN B DESIGN – STEEL HELICAL PIERS, SLAB SUSPENDED WITH LIFTING MECHANISMS

An alternate design option was introduced in the middle of the design process as a potential lower-cost option to *PLAN A*. The *PLAN B* design was based upon the SlabTek System patented slab lifting process. The SlabTek System process creates a structurally suspended slab that is poured in place similar to a slab-on-grade and then suspended once the slab is cured and the post-tension cables are stressed. The slab is suspended by the SlabTek System lifting mechanism that are embedded into the slab at the time of the pour. The suspended slab creates a void similar to the traditional carton form method, but without the cost and issues associated with carton forms.

NOTE: It was imperative that no structural design compromises be made in an effort to save cost.

SlabTek's *PLAN B* design provides the same level of design integrity and reliability as the *PLAN A* traditional foundation design, but at a substantially reduced cost and reduced schedule risk.

THE FOUNDATION DESIGN

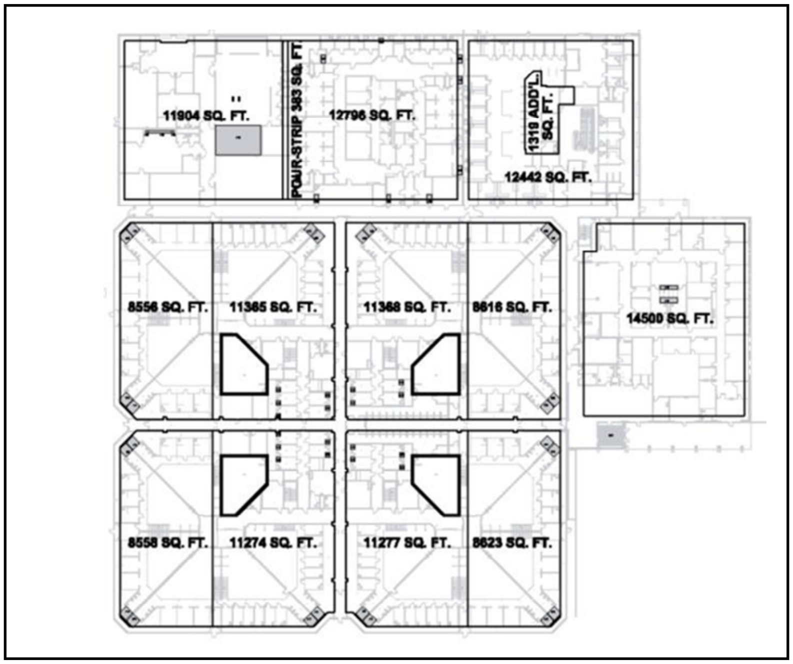
In both *PLAN A* and *PLAN B*, the design of the foundation consists of seven separate slabs. The plans show the seven slabs separated by pour strips or jacking strips. Included are heavy 24-inch diameter drilled concrete piers installed in the center of the pour strips. The tilt-up wall panels will be set on top of the heavy piers around each slab and in between slabs.

In addition, the plans included heavy 18-inch drilled concrete piers installed on the interior to support the structural columns that support the roof framing.

The entire slab area, including pour strips and entry areas, is approximately 150,000 square feet.

Section	Sq. Footage
C	24,700
D	13,762
E	14,500
F	19,984
G	19,921
H	19,832
J	19,900
	132,599

PLUS Pour / Jacking Strips



PIERS – DRILLED CONCRETE VS. STEEL HELICAL

Both *PLAN A* and *PLAN B* designs are based upon sound engineering principles, however, each has its own unique approach toward the type of piers utilized and slab thickness. The major differences is in the type and number of piers, and slab thickness.

24" Dia. Concrete Piers and 2" Dia. Steel Helical

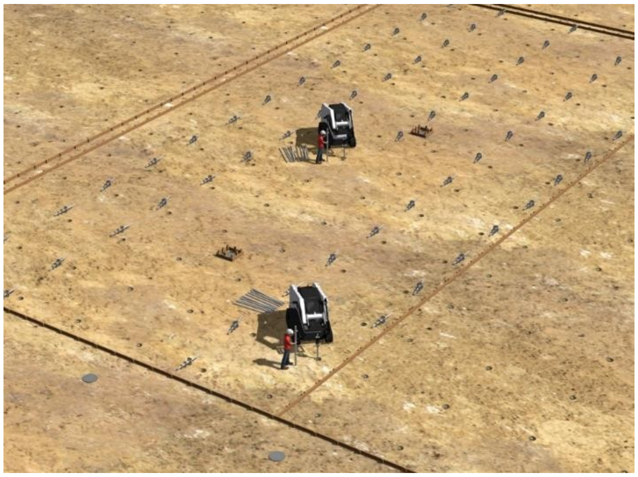
PLAN A: HEAVY DESIGN

Smaller Number of Higher-Cost Piers,
Spread Apart with Thicker, More Expensive Slab

The traditional slab-on-carton-form design uses the principles of *HEAVY DESIGN*. Heavy drilled concrete piers are expensive and therefore the goal is to minimize the number and size of the piers by maximizing the space between each pier i.e. increasing the spacing between piers throughout the slab as much as possible. As piers are spaced further apart the slab that is being supported by the piers must increase in strength in order to span the increased space between piers. As the distance between piers is increased, the thickness of the slab must be increased, if the pier spacing is reduced, the thickness of the slab can be reduced.

Drill truck drilling 18" and 24" diameter piers

The *HEAVY DESIGN* incorporates 18" diameter drilled concrete piers to support the slab. The optimal spacing / slab thickness drove the requirement for 327 drilled concrete piers with 18" diameters, spaced 25' – 30' apart to support the slab. The slab thickness was required to be 10" thick to achieve the strength necessary to span the piers.



Skid steer with auger motor installing Helical Piles

PLAN B: LIGHT DESIGN

Larger Number of Lower-Cost Piers,
Closer Together with Thinner, Lower Cost Slab

SlabTek's Design uses the principles of *LIGHT DESIGN*. It accomplished this by incorporating steel helical piers instead of drilled concrete piers. Since steel helical piers are significantly lower cost vs. 18" or 24" diameter piers, a greater number can be used and still be total cost equivalent. Using a large number of helical piers enables reduction in the pier spacing, and thereby allows for a much thinner slab to achieve the strength necessary to span the piers.

The *LIGHT DESIGN* also incorporates 1.5” and 1.75” square-shaft helical piers with 3 helix plates, 8”, 10” and 12” in diameter. The optimal spacing / slab thickness drove the requirement for 1,614 steel helical piers, spaced 10’ – 12’ apart to support the slab. The slab thickness was required to be only 5” thick (half the carton-form slab) to achieve the strength necessary to span between the piers.

	SLAB ON CARTON FORMS	SLABTEK SYSTEM
Structurally Engineered:	Yes - high quality	Yes - high quality
Slab Type:	P.T. Structurally Suspended	P.T. Structurally Suspended
Slab Thickness:	**10”**	**5”**
Suspension / Void Method:	**Void Boxes**	**Slab Lifting Bolts**
Structural Support Piers:	24” Ø straight shaft concrete	24” Ø straight shaft concrete
Structural Pier Qty.:	98	98
Slab Support Pier Type:	18” Ø straight shaft concrete	Steel Helical Piers
Slab Concrete Pier Qty.:	**327**	0
Slab Helical Pier Qty.:	0	**1,614**
Number of Slab Pours:	**14** separate pours	**7** separate pours

.

Comparison of Slab-on-Carton-Forms vs. SlabTek System

STRUCTURAL COLUMN POINT LOADS – HEAVY STRUCTURAL PIERS

Both the *HEAVY DESIGN* and *LIGHT DESIGN* must be capable of supporting heavy point loads from structural columns. In both cases, heavy structural piers must be located under the point loads. In the *HEAVY DESIGN* the slab is placed over the structural piers and the steel columns are attached to the slab.

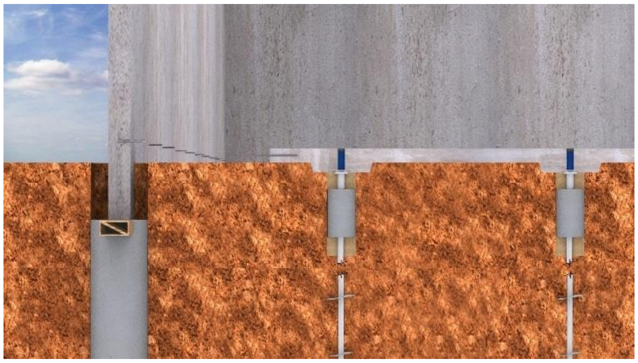
In the SlabTek Design, a leave-out is located in the slab over the structural pier. The structural column will be attached directly to the pier and the slab is lifted independently of the structural columns.

***Shown to the right is a 5” thick slab supported by helical piers. The slab is lifted around a steel structural column supported by a heavy structural concrete pier. Once lifted, the gap around the column is grouted in*.**

TILT-UP WALL PANELS

Both designs included concrete tilt-up wall panels for the exterior and some interior walls between sections of the jail. The panels will be cast on site. The tilt-up panels will provide both an economical method of exterior walls and provide security for both exterior and interior walls. The tilt-up support piers were identical for both *PLAN A* and *PLAN B* designs. 24" diameter concrete piers are drilled and installed along the entire perimeter of the wall panels, and the wall panels are supported directly on the heavy piers.

Erecting the tilt-up wall panels on heavy piers



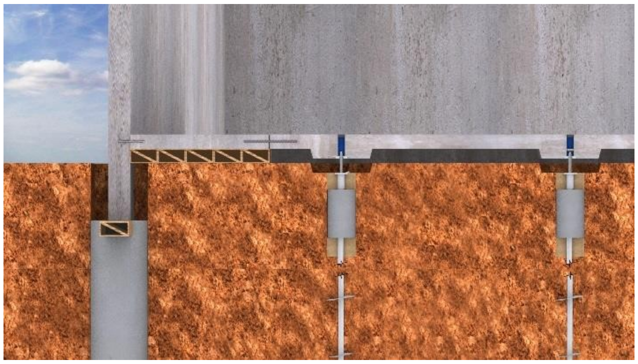
Wall panels in place, ready for the slab to be lifted

Slab lifted to create protective void under the slab

The slabs are installed with a 5' gap between the edge of the slab and the wall panels. This gap or strip allows room for stressing of the post-tension cables and allows final plumbing and other utility installations. Once completed, the pour strip is filled with concrete making the slab contiguous up to the walls.

In the case of the SlabTek Design, the slab is first lifted before the pour strips are installed. Once the slab is lifted, carton forms are placed in the pour strip area and the area is poured with concrete tying the pour strip into the lifted slab and the wall panels.

Carton forms are placed in the pour strip area



Pour strip is poured and tied into the slab and panels.

CREATING THE VOID SPACE

The purpose of the void under the slab is to mitigate any possibility that expanding soils will cause heave damage to the foundation. SlabTek recommends that the void be at least 1.5X the maximum PVR as a safety factor. **In this case 1.5 X 6-1/4" = 9-1/8" void.**

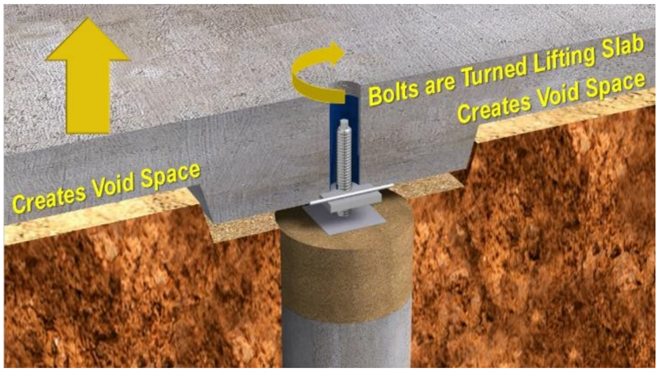
When designing a foundation with carton forms or void boxes, it is recommended that the thickness of the carton forms be 20% thicker than the actual required final void space. This extra safety factor will accommodate the potential 20% compaction of the void boxes as the concrete is poured.

The SlabTek System lifting mechanism does not require any safety factor on the lift. The height of the lift is exactly equal to the height of the final void.

The void space created by a 12" carton form will be similar to the void space created by lifting the slab 10" in height.

12" carton form height X 80% = 9.6" ≈ 10" slab lift with lifting mechanism.

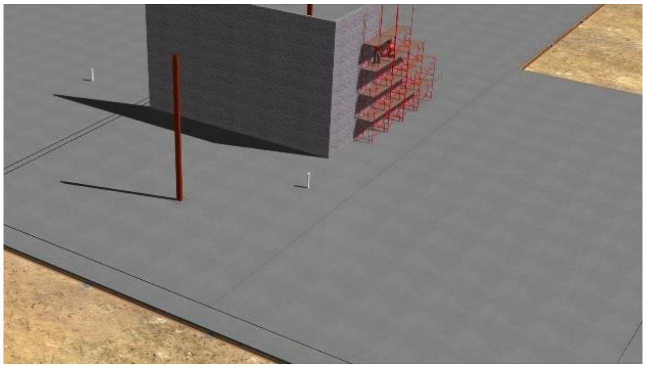
Lifting Mechanism on top of helical pier



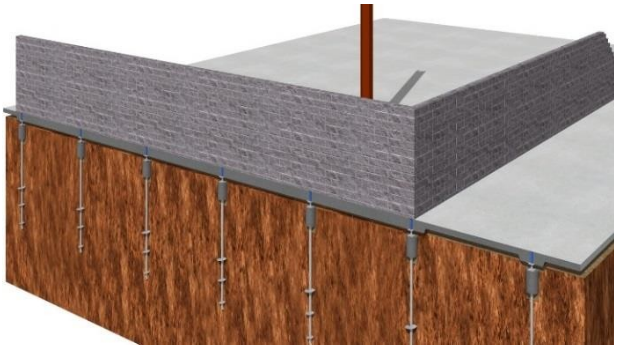
Bolt in Lifting Mech is turned lifting slab, creating void

SUPPORTING HEAVY CMU WALLS

The design includes tall CMU walls to be placed on top of the slab creating hallways and other rooms. In the case of the 10" slab with concrete piers, this can be easily accomplished. However, in order to carry the load of the CMU walls on a 5" slab, steel helical piers need to be placed under the wall, and the slab is strengthened with a small 10" thickened area or shovel beam.



CMU walls erected on top of the slab



Helical piers are placed under the CMU walls

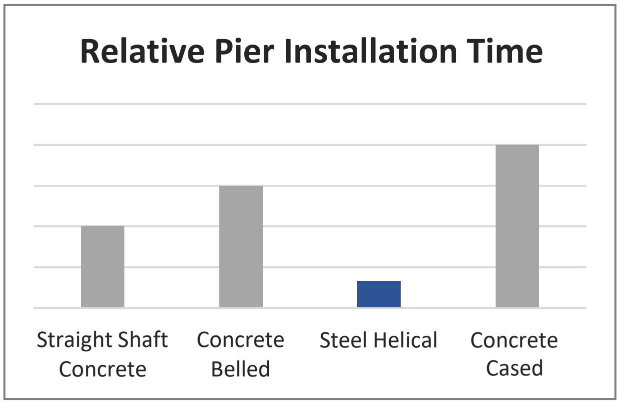
TIME SAVINGS – COST SAVINGS

The SlabTek System not only saves concrete, heavy piers, and labor, it also saves time in the schedule, especially when it comes to unpredictable weather. The three primary schedule saving items are outlined below.

- Pier installation is much faster utilizing Steel Helical Piers vs. Concrete Drilled Piers
- Slab make-up is faster because of the elimination of carton forms.
- Slab pours are faster due to half the amount of concrete required in the slab.

SCHEDULE SAVING HELICAL PIERS INSTALLATION

Steel Helical Piers are a modern alternative to cast-in-place concrete piers. They are especially suited to situations in which the geotechnical soils report indicates the presence of water, or if moisture is encountered during the pier drilling process. In the time it takes to drill the shaft for a typical concrete pier, multiple helical piers can be installed with a single piece of equipment. In addition, there are no spoils to dispose of, no reinforcement to fabricate or install, and no waiting for concrete to cure.



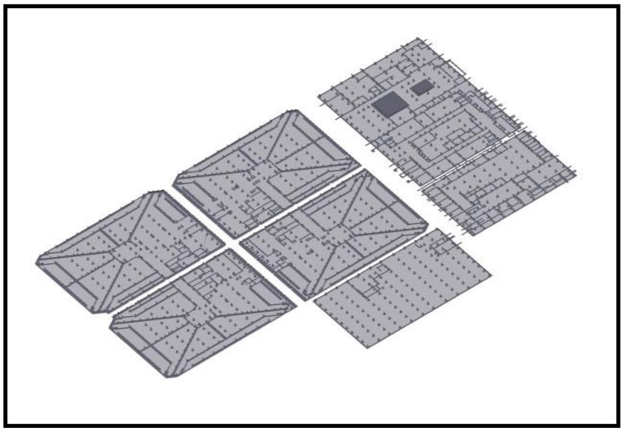
STEEL HELICAL PIERS INSTALLS – MORE RAIN TOLERANT

Helical Piers are installed with lightweight track loaders or skid-steer loaders. Because this equipment is much smaller & lighter than typical drill trucks, helical piers can be installed much sooner after a rain.

Shown on the right is a helical piers installation at a very muddy job site. The helical piers were installed in the afternoon only three hours following 4 – 5 hours of rain in the morning.

1,600 STEEL HELICAL PIERS

The Comal County Jail design will incorporate over 1,600 helical piers as shown in the design rendering on the right. Each little dot in the drawing represents an individual helical pier.



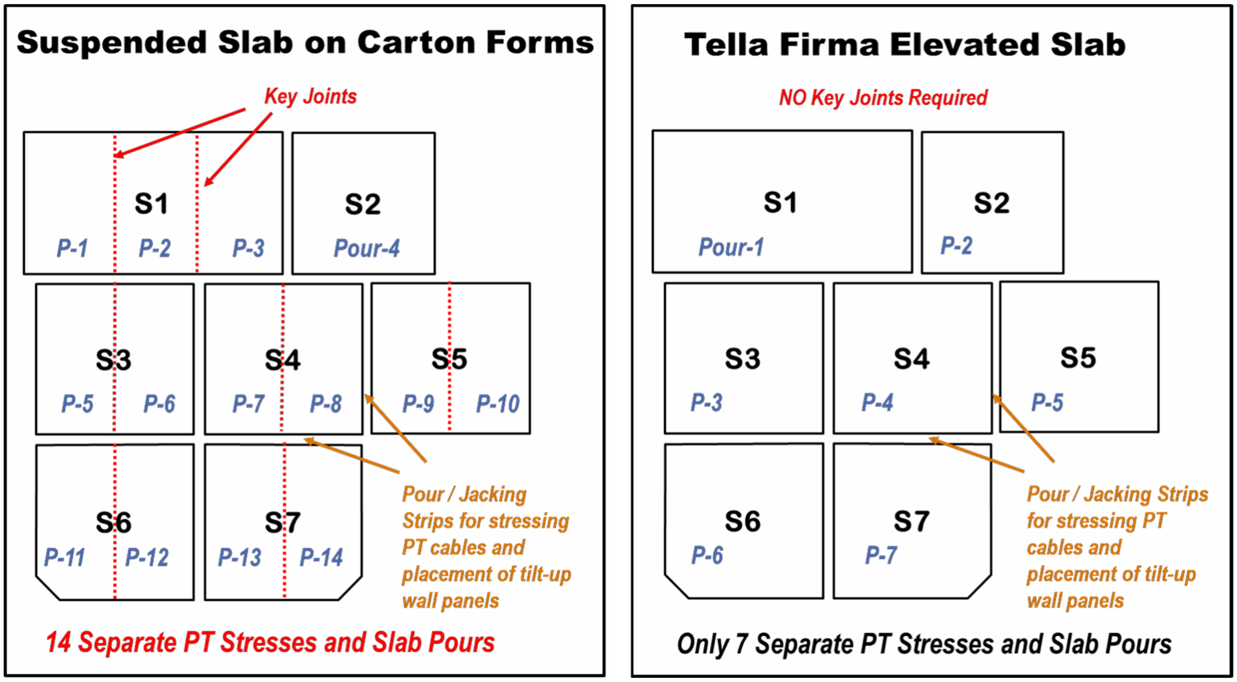
The estimated time to install approximately 250 piers in each of the 7 slabs is 3 days per slab.

ELIMINATION OF CARTON FORM BOXES REDUCES RISK AND SCHEDULE TIME

As most general contractors and concrete subcontractors know, there are significant time and cost risks when using carton form boxes. Thousands of square feet of carton forms can be damaged by rain, making them non-functional in slab suspension. Should the carton forms become wet prior to pouring the slab, the concrete subcontractor will have to remove all the PT cables and rebar installed during slab make-up, replace all of the carton forms, and completely make up the slab again.

If *PLAN A* is used, the decision was made to pour each of the 7 major slabs in sections, reducing the risk of replacing carton forms on an entire slab. Each time the slab is poured, the slab must cure before the cables are stressed before the next section of the slab can be poured. The total number of individual PT stressing and **individual slab pours is increased to 14 versus only 7 for the SlabTek System slab.**

If *PLAN B* is used, there is no need to pour in small sections. The SlabTek System elevates or suspends the slab with lifting mechanism and does not require carton forms. Therefore, the system significantly reduces the schedule risk associated with wet weather.



The SlabTek System saved 28 days of schedule in the PT stressing and slab pouring

CONCLUSION

The SlabTek System is an excellent alternative to the traditional slab-on-carton-form designs. In the case of the Comal County new jail project, the SlabTek System is a high-quality structural foundation design that will save nearly $1 million in total costs to the county taxpayers.

SlabTek Company – Commercial Construction
Release Date – May 15, 2018

This product and implementation of suspended slabs using this product are protected by the following United States and Canadian Patents which are owned exclusively by SlabTek US Patents: 8458984, 8671627, 8407898, 8678712, 7823341 B2, 8069620 B2.
Canadian Patent: 2628422

For more information contact:
SlabTek Company
2505 N. Plano Road, Suite 400
Richardson, TX 75082
Phone: 214.451.6630
Visit our web site and watch our videos at:
www.SlabTekCompany.com