25 April 1991

M. Lewis Coody, P.E.
Ronald J. Kruhl, P.E.
P.O. Box 10355
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Anchor Foundation Repair Co., Inc.

RE: Pressed Pile System

In accordance with your request, we have reviewed the literature you provided us on the "pressed pile system" (PPS) which uses six inch diameter by twelve inch long unconnected concrete cylinders with a large concrete block pile cap. We have evaluated this underpinning method in general and made comparisons to the foundation repair system utilizing drilled piers with underreams. The following discussion reflects our most prudent professional opinions based on our knowledge of and extensive experience in commercial and residential foundation design involving expansive clay soils. We certify that we made the study as independent professional engineers and have no interest, present or prospective in either the PPS or drilled pier system or anyone involved with these systems.

Live Loads Required By Building Codes

It is stated in the PPS "Specifications for the Design and Installation of Underpinning for the Foundation of a Structure" provided by you that the piles shall be designed to permit only an "acceptable" amount of settlement in supporting a combination of all dead loads and live loads required by the applicable building codes. The dead load of the structure and only the actual live load superimposed at the time of installation are used to resist the jacking

force required to install the PPS. In most cases the actual live load, at any given time, is a very small percentage of the live load required by the building code. The PPS, therefore, will not be capable of supporting the maximum combination of dead load and live load as stated in the specifications without excessive settlement. Furthermore, since only the dead load and existing live load at the time of installation are used in resisting the jacking force no factor of safety can be incorporated. Responsible engineering practice is always based on some reasonable factor of safety. If the live load is increased, until it reaches that which is required by the building codes, the structure could experience differential settlement which would most likely be far beyond "acceptable" limits

On the other hand, the drilled pier with its large bearing area provided by the underream has the capacity to resist additional loads. The combination of skin friction on the larger shaft and the much larger bearing area of the underream results in low initial shear and bearing stresses on the soil. This leaves reserve capacity to support increased live loads required by the building code. The proper combination of pier spacing, shaft diameter and underream diameter as well as bearing depth can provide a factor of safety to prevent future settlement which is consistent with good engineering practice.

Characteristics of the Driven Pile

Piles pressed into clay deposits will be characterized as being either friction piles or point bearing piles. The character of the pile will depend on the type of clay and moisture content of the clay at the time of installation. If the pile encounters a soft saturated plastic clay it will take on the characteristics of a friction pile. Although the term friction pile implies that the shearing forces between pile and soil are derived from friction, they may also consist of surface adhesion. If a friction pile has parallel sides, as does the PPS, the load is transferred from the pile to the soil principally through shear. If piles are driven in soft saturated plastic clay the shear consists primarily of adhesion and very little resistance is derived from true friction. When seasonal drying occurs, it progresses from the surface downward and as the clay gives up moisture, the shear resistance (friction due to adhesion) will be lost as the plastic clay shrinks away from the pile. To maintain the applied load capacity

the lower levels of the pile will have to develop increased resistance. For this to happen the lower portion of the non-tapered PPS will have to settle to encounter clay soil of higher consolidation or less compressability. Settlemen must occur to encounter increased soil strength at greater depths to develop and maintain resistance to a given load. Most likely this settlement will not be equal throughout the structure and the structure will inherently fail (or fail again) due to the resulting distress.

Furthermore, there is no assurance that the PPS will be driven straight or what the effective length of the pile will be in soft saturated plastic clays. If one portion of the tip section encounters a foreign object such as a rock or tree root it may skew off to one side. This tip section may in turn cause other sections of the pile to skew off as well. This, of course, could not be detected by the installer. Although a large number of sections may be jacked into the ground there is no guarantee that the pile is deep and that adequate long term capacity will be sustained.

Conversely, if the pile encounters a stiff unsaturated plastic clay when pressed, it will take on the characteristics of a point bearing pile which contradicts the initial assumption of the PPS. Piles installed in stiff, unsaturated plastic clay will typically be shallow because the stiff clay will be capable of developing possible high shearing (skin friction) resistance, and considerable point bearing resistance. As seasonal changes occur, the clay will again become saturated. As the moisture migrates downward the clay soil at the tip of the shallow pile will begin to loose the high bearing strength it possessed in the unsaturated state. The PPS has a non tapered shaft and a smal bearing area. Settlement will occur when the high compressive stresses in the soil under the pile tip exceed the now reduced compressive strength of the saturated soil.

Conclusions

The pressed pile system when compared to drilled piers with underreams has several inherent disadvantages. Settlement can occur in varying amounts after the piles are pressed into saturated expansive clay soil because friction resistance will be lost when the soil loses moisture and pulls away from the

pile. Settlement can also occur after the piles are pressed into unsaturated expansive clay soil because bearing resistance is lost when the soil gains moisture and loses its compressive strength.

Also, the unconnected sections and the non integral pile cap of the PPS will not provide resistance to uplift which will occur when the moisture content of the unsaturated clay soil increases. Uplift will cause material distress to the structure similar to settlement.

The pier and underream system is not as susceptible to loss of load carrying capacity and settlement due to the effects of change of moisture content because the primary load carrying element, the underream, is located at a depth where the moisture content of the soil is constant or changes very little. The underream on a reinforced drilled pier not only reduces compressive bearing stresses on the soil but also acts as an anchor to resist uplift forces on the upper portion of the pier. The underream prevents the pier from rising and lifting the structure above its original position. The reinforced drilled pier with underream has definite advantages over the pressed pile system for eliminating long term settlement and uplift on expansive clay soils.

We trust these comments will be helpful to you. If we can be of further assistance please let us know.

Sincerely,

M. Lewis Coody, P.E.

Ronald J. Kruhl, P.E.

enclosures

RESUME

M. LEWIS COODY

ADDRESS:	Rt. 4, Box 515, Hopes Creek Rd., College Station, Texas 77840
MAILING ADDRESS:	P. O. Box 10355, College Station, Texas 77842
PERSONAL INFORMATION:	Age - 46; U.S. Citizen; [redacted] Birthplace: Lawton, Oklahoma; Marital Status: Single
EDUCATION:	Bachelor of Architectural Engineering - Oklahoma State University Master of Science, Civil Engineering (Structural) - Oklahoma State University Completed course work for Ph.D., Civil Engineering (Structural) - Texas A&M University (Re: Enclosure 1, List of courses).
ACADEMIC EXPERIENCE:	Assistant Professor, Texas A&M University. College of Architecture and Environmental Design. Department of Construction Science Upper level structural engineering courses from January 1971 to present.
PROFESSIONAL EXPERIENCE:	Consulting structural engineering on a part time basis for several Architects and Design/Build Contractors from July 1971 to present (Re: Enclosure 2, List of Projects).
PROFESSIONAL REGISTRATION AND ORGANIZATIONS:	Registered Professional Engineer, State of Texas American Concrete Institute American Institute of Steel Construction

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EDUCATION

B.S Engineering Science, 1968, University of Texas at Austin.Electives in Civil and Architectural Engineering.

M.S. Civil Engineering, 1971, University of Texas at Austin, Structural Engineering Option Minor in Architectural Engineering. Thesis Title: "Structural Behavior and Durability of Some Prefabricated Wall Panels."

Registration: Professional Engineer, Texas Number 38192

PROFESSIONAL EXPERIENCE

August 1977 to present: Assistant Professor of Building Construction, Texas A&M University, College Station, Texas. Teaching statics, strength of materials, structural steel design, and design of reinforced concrete structures.

Private practice as Consulting Structural Engineer Ronald J. Kruhl - Structural Engineers.

List of clients and projects performed in private practice as a Consulting Structural Engineer.

1. August 1988 to Present: Retained as expert witness by the law offices of Windle Turly P.C., Dallas, Texas representing plaintiff in negligence suite in Dallas, Texas.

2. May 1988 to October 1988: Design of wastewater system for cannery at Ramsey II Unit of the Texas Department of Corrections. Huntsville, Texas.

3. February 1988 to Present: Design of $15 million hotel in Cincinnati Ohio, a joint venture with Paul Hemmer Construction Company, Ft. Mitchell Kentucky and Surbana Hotels Inc. Cincinnati, Ohio.

4. Novemer 1987 to February 1988: Retained as expert witness by Chicago Bridge and Iron, Houston, Texas, concerning crane failure at Marathon Oil Company Refinery Texas City, Texas.

5. September 1987 to December 1987: Structural Design of McDermott Residence, College Station, Texas. Ray Britton Architect.

6. September 1989 to May 1988: Renovation of historic St. Andrews Episcopal Sunday School Building, Bryan, Texas.

7. December 1986 to December 1987: Conducted study of the existing heating and ventilating system for seven prison units of the Texas Department of Corrections, Huntsville, Texas.

8. January 1987 to April 1987: Designed two story Laundry facility for Winn Unit, Texas Department of Corrections, Huntsville, Texas.

9. October 1986 to December 1986: Formwork Design for Metro - Con Inc. Trinity University, San Antonio, Texas.

10. April 1987 to December 1987: Design of Conroe Baptist Church Conroe, Texas for Liberty Panels, Inc., Silsby, Texas.

11. March 1986 to May 1988: Design of U.S. Postal Facility, College Station, Texas. A joint venture with MLC Associates , College Station, Texas.

June 1973 to August 1977: Project Engineer, Lockwood, Andrews & Newman, Inc., Consulting Engineers, Austin, Texas. Responsible of r the preparation of technical reports, designs, construction drawings and specifications for structural, civil and municipal type projects.

April 1972 to June 1973: Project Engineer, Prescon Corporation, San Antonio, Texas. Coordinated structural projects involving post-tensioned concrete, designed mechanical systems for hydraulic equipment, researched project potential for post-tensioned application and made cost estimates.

November 1971 to April 1972: Engineering Assistant, Seidel, Livesay and Davis Inc., Consulting Engineers, San Antonio, Texas. Designed and prepared working drawings for structural and mechanical systems.

January 1969 to May 1, 1971: Graduate student and research assistant at University of Texas at Austin. Majored in Structures Division of Civil Engineering; Minored in Architectural Engineering. Performed laboratory research in Architectural Engineering.

MEMBERSHIPS

American Society of Civil Engineers, Texas Society of Professional Engineers, National Society of Professional Engineers.

PERSONAL

Born Burnet, Texas, July 26, 1945. Hometown, Austin, Texas.