

**GEOTECHNICAL AND CONSTRUCTION MATERIALS ENGINEERING SERVICES
FOR A TYPICAL RESIDENTIAL STRUCTURE
IN THE HOUSTON METRO AREA****01-22**Introduction

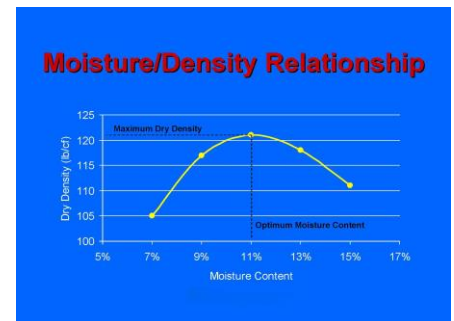
Performance of residential structures depends very much on proper design and construction of the foundations. Soil/structure interaction should always be considered in the design phase of foundations. Adequate quality control and inspection at the time of the construction is as important as proper design of foundations.

The purpose of this work plan is to identify the required design parameters and recommend quality control and observation requirements for residential structures.

It is recommended that a designer/builder include this work plan in his/her bid to the owner to inform him/her of design/construction requirements, potential problems and liability that can arise from the improper design and construction of foundations. In general, the cost of foundation repair is significantly greater than conducting a proper geotechnical study and maintaining proper quality control at the time of project construction.

Typical Foundations

Foundations for support of residential structures in the Houston area consists of structural slab on pier type foundation, slab-on-fill supported on piers, conventionally reinforced slab, or a post-tensioned slab. In general, the performance of structural slab on pier foundations is better than a conventionally reinforced slab or a post-tensioned slab. However, the cost of a structural slab on pier type foundation is greater.

Geotechnical Engineering Services

The initial foundation design parameters can be developed by performing a geotechnical study of the project site.

The geotechnical studies will include drilling two or more undisturbed sample borings to depths ranging from 15- to 20-feet, laboratory testing and an engineering report. Deeper borings must be drilled in the areas that trees are present or have recently been moved and the subsoils are expansive. The engineering report will include recommendations on site preparation, earthwork, foundation type, depth, allowable loading and Homeowner Maintenance Program. The geotechnical study should also address potential problems with expansive soils, site drainage, the required fill type under the floor slabs, the use of void boxes, and the effect of trees on the foundations.



We recommend that a minimum of two borings be performed at each project site. Past experience indicates that subsoils within a lot can vary significantly. The design soil parameters should be developed on the basis of weaker soil boring conditions to minimize potential foundation settlement.

Construction Materials Engineering Services

General. Construction monitoring and quality control tests should be planned to verify materials and placement in accordance with the project design documents and specifications. Earthwork observations on the house pad, pad thickness measurements, drilled footing installation monitoring, and concrete placement monitoring should be performed. Details of each of these items are described in the following paragraphs.



Proofrolling Observations. The house pad area should be cleared of all vegetation, roots and any other debris. Then the area should be proofrolled with a loaded dump truck to locate any soft areas. These soft areas should be removed and replaced with on-site soils or select fill and recompact or stabilized and recompact.

Earthwork Observations. The subgrade and fill soils under the floor slabs should be compacted to about 95 percent of maximum dry density (ASTM D 698). Furthermore, the fill soils should be non-expansive. Atterberg limit tests should be performed on the fill soils, obtained from the borrow pit, to evaluate the suitability of these soils for use as structural fill and their shrink/swell potential.

Field density tests should be conducted on the subgrade soils, and any borrow fill materials in the floor slab and pavement areas. In the areas where expansive soils are present, about 24 to 48-inches of structural fill is placed under the floor slab areas. Laboratory proctor tests will also be performed on the on-site soils as well as off-site borrow fill materials to evaluate the moisture-density relationship of these soils.



Fill Thickness Verification. Fill soils may have to be placed on the lot to raise the lot or to provide a buffer zone in between the on-site expansive soils and the floor slabs. We recommend that the required thickness of the fill be verified after the completion of the building pad. This task can be accomplished by drilling two borings to a depth of five-feet in the building pad area, examining and testing the soils to verify the fill thickness.

Drilled Footing Observations. In the event that the structure is supported by drilled footings, we recommend that the installation of the footings be observed by a geotechnical technician.

The four corner piers of the house should be drilled first to establish the proper footing depth. The technician will conduct hand penetrometer tests on the soil cuttings to estimate the bearing capacity of the soil at each footing location. He will make changes to the foundation depth and dimensions if obstacles, groundwater or soft soils are encountered; therefore, minimizing costly construction delays. In addition, the technician must verify the bell size by a bell measurement tool. Two sets of concrete cylinders (eight cylinders) will be made for each day of pour. Four cylinders will be broken at seven days, and four cylinders at 28 days.



Concrete Placement Monitoring. The concrete sampling and testing in the floor slab and placement areas will be conducted in accordance with ASTM standards. A technician will monitor batching and placing of the concrete. Twelve concrete cylinders will be made for each floor slab pour. Six concrete cylinders are tested at seven days and six cylinders at 28 days.



Cost Estimate

Geotechnical. In general, the cost of a geotechnical exploration for a typical residential structure in Houston ranges from \$1,170 for two, 15-ft borings and \$1,550 for two, 20-ft borings. The cost assumes that the site is accessible to a truck-mounted drilling rig. The cost estimate also includes laboratory testing, engineering analyses, recommendations and Homeowner Maintenance Program.

Construction Materials Engineering. The cost of performing construction materials engineering work will vary depending on project location and scope of work. We provide our services on a time and materials basis. We have estimated the required number of hours and testing requirements for the above-mentioned services. The details of our cost estimate are presented on Plate 1. In order to provide the most accurate estimate of the testing and inspection services, the actual construction schedules and climatic data are necessary. Services will be billed monthly, with payment due on presentation.



A contractor/designer shall submit this document to the prospective homeowner for approval. This will enable the builder to construct a better-quality foundation system for the structure with much less liability exposure.

Conclusion

Proper geotechnical and construction materials engineering studies for residential projects in the Houston metro area will result in a quality foundation system for the residential structures. This will also significantly reduce potential liability problems to the builders/designers. In general, the cost of performing these studies are minimal compared to the total cost of the project and potential foundation repair costs.



If you have any questions or would like to discuss Construction Materials Engineering Services during the construction phase, please contact Geotech Engineering and Testing at 713-699-4000 or at de@geotecheng.com.



**ESTIMATED COST FOR
CONSTRUCTION MATERIALS ENGINEERING SERVICES**

Services	Unit Price	Unit Measure	Quantity	Cost
<u>Earthwork Testing</u>				
Proctor Pick-Up/Proofrolling Observations	\$63.00	hour	4	\$252.00
Standard Proctor Tests	231.00	each	2	462.00
Atterberg Limit	71.00	each	2	142.00
Percent Finer No.200	55.00	each	2	110.00
Transportation	75.00	day	1	75.00
In-Place Densities for Subgrade Compaction:				
Technician	63.00	hour	4	252.00
Transportation	75.00	day	1	75.00
Nuclear Gauge	50.00	day	1	50.00
In-Place Densities (Two Lifts):				
Technician	63.00	hour	8	504.00
Transportation	75.00	day	2	150.00
Nuclear Gauge	50.00	day	2	<u>100.00</u>
			Subtotal	<u>\$2,172.00</u>
<u>Drilled Footing Observations</u>				
Senior Technician	\$63.00	hour	12	\$756.00
Transportation	75.00	hour	2	150.00
Concrete Compression Tests	20.00	each	8	<u>160.00</u>
			Subtotal	<u>\$1,066.00</u>
<u>Concrete Floor Slab Observations</u>				
Technician	\$63.00	hour	10	\$630.00
Transportation	75.00	day	1	75.00
Concrete Compression Tests	20.00	each	12	<u>240.00</u>
			Subtotal	<u>\$945.00</u>
<u>Project Management</u>				
Project Manager	\$176.00	hour	6	\$1,056.00
Typing	60.00	hour	6	<u>360.00</u>
			Subtotal	<u>\$1,416.00</u>
			Estimated Total	<u>\$5,599.00</u>