

**Request for Research Funding for FY 2022-2023**

**SPR Subpart B Project: GEO-23-01**

<b>Requesting Office</b>	Geotechnical	<b>Priority</b>	1 of 4
<b>Proposed Title</b>	Effect of spacing on axial resistance of Augercast pile foundations		
<b>Justification</b>	<p>The adoption of the design-build model for contracting work has resulted in some positive aspects, mostly related to time savings and coordination between designers and the Contractor. On the other hand, it has reduced the influence that the Department has on the details of foundation design, one example of such an instance is related to the selection of spacing between foundation elements. Historically under conventional contracts (design-bid-build), deep foundations were designed at a spacing of at least 3 times the pile width center to center, and smaller spacings would only be considered if a pile was rejected during construction and sister piles were required. The observed trend in Design Build projects, particularly the ones using Augercast pile foundations, has been the push for 2.5 diameters spacing center to center, resulting in smaller pile caps, and hence time and cost savings. Given that the AASHTO design code is silent on how to address the issue of spacing in rock or intermediate geomaterial (IGM) from a foundation design perspective, it is necessary to perform the evaluation through research locally to ensure the bearing layer is not being over-stressed. The aspects that the effort would cover include the effect of proximity on settlement and bearing resistance as a function of bearing layer strength and foundation diameter, as well as the computation of the overlapping stress bulbs between foundation elements, and the associated strains and shear forces, from which an evaluation of the reliability of the overall foundation can be computed. The project would address the question using Finite Element modeling, numerical methods and small-scale physical model tests.</p>		
<b>Impact</b>	The work could result in the development and implementation of axial design factors that could be implemented in the Structures Manual – Volume I, if needed.		
<b>Affected Offices</b>	Structures Design and Construction. We plan to work closely with Juan Castellanos from the Construction Office		
<b>Existing Work</b>	<p>Examples of work on similar topics:</p> <p><u>Shallow foundations</u>: Anaswara et al., Interference Studies of Adjacent Strip Footings on Unreinforced and Reinforced Sands (2020)</p> <p><u>Ground modification</u>: Wang et al., Behavior of composite foundation reinforced with rigid columns (2019)</p> <p><u>Driven piles</u>: Gandhi and Selvam, Group effect on driven piles under lateral load (1998)</p>		
<b>Keywords Used In Existing Work Search</b> <b>(Cannot leave blank)</b>	Foundation spacing, pile spacing, pile group efficiency, settlement due to pile spacing		
<b>Related Contracts</b> <b>(Give contract numbers)</b>	None		
<b>Funding Request</b>	Estimated cost: \$250,000	<b>Anticipated Duration</b>	24 months
<b>Project Manager</b>	PM: Rodrigo Herrera Co-PM: Juan Castellanos	<b>Contracting Method</b>	Direct contract with the University of Central Florida. Dr. Luis Arboleda-Monsalve
<b>Equipment</b>	\$25,000	Actuator for small scale testing apparatus, materials for the construction of synthetic rock and associated instrumentation (pressure cells, strain gauges, data acquisition)	

<b>Urgency</b>	1	The situation should be addressed as soon as practical to ensure adequate design of foundation elements.
<b>Implementability</b>	1	If the research finds that revisions to the Structures Manual are required, they can be implemented on the next available version of the document

Project Benefits (Succinct, complete explanation)

The results of preliminary analysis performed for a separate effort by the University indicated that the capacity and the overall foundation response is highly affected by the S/D ratio and the relative stiffness factor  $E_{top}/E_{bottom}$ . In the case of loose sand overlying competent weathered Limestone the required load to produce plunging failure did not vary with the S/D ratio which is very encouraging in the sense that it suggests no correction factors would be needed. However, as expected, low S/D ratios did cause a more flexible response in terms of load-deformation. The benefit of this project will be in the quantification of the effects of the foundation layout and rock strength on the anticipated performance of the superstructure. In addition, site-specific analyses and calibration of bearing capacities using advanced rock models for the case of Florida limestone will be implemented to study the failure mechanisms and influence of pile spacing ratio (S/D), relative stiffness factor ( $E_{top}/E_{bottom}$ ) and effect that other parameters such as Recovery and RQD have on foundation deformation characteristics.

<b>Project Benefits (Select all that apply and explain)</b>	<b>Quantifiable Benefits (units, dollars, etc...if applicable)</b>	<b>Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits</b>
<input type="checkbox"/> Materials Enhancement	Possible	If the effort indicates the use of 2.5D spacing is not an issue, there would be material and time savings given the reduced area required for pile caps
<input type="checkbox"/> Materials Savings	Possible	If the effort indicates the use of 2.5D spacing is not an issue, it could be adopted by designers more often making construction faster and using less concrete and steel
<input type="checkbox"/> Time Savings	Possible	If the effort indicates the use of 2.5D spacing is not an issue, it could be adopted by designers more often making construction faster and using less concrete and steel
<input type="checkbox"/> Lives Saved/Injuries Prevented	Significant	Every project that focuses on investigating foundation reliability, whether on testing and design or construction methods, is directly tied to the safety of the traveling public
<input type="checkbox"/> Other (Explain)	Advancement of the state-of-practice	This effort will result a comprehensive analysis of the influence of proximity of pile foundations on overall superstructure performance.

\*Comments should explain and support urgency, financial benefit, and implementability scores