Deliveriable # 1

Senior Design Group #4

Eglin Air Force Base: Crushed Test

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Needs Assessment:

AFRL is interested in studying the mechanical and dynamic properties of a steel cylinder as it undergoes an external quasi-hydrostatic pressure. The purpose is to be able to apply a variety of compressive forces at varying lengths along the cylinder. The pressure will be applied using an incompressible media, like concrete, through an applied external compressive force. Steel plates will then be placed around the substrate and be tightened uniformly until a multi-axial compressive load is applied to the surface of the steel cylinder. A series of dynamic tests would then be performed on the cylinder to determine the system behavior under these loading conditions.

Project Scope:

Problem Statement:

The principle objective of the project is to design this system such that compressive force on the outer diameter of the cylinder can be determined based on the stresses in the plate and the applied torque.

Objective:

The team is expected to develop a system that can apply a quasi-hydrostatic to a steel cylinder and a way to determine the applied stress on the cylinder through the clamping force in the plates and strain on the plate. For the final design no sensors can be applied to the cylinder or in the concrete. This system must be segmental in nature can be combined to apply a continuous load over the entire length of the cylinder and the steel forms must be able to be re-used. Future iterations of this project will include looking at other types of media like gravel, sand, or crushed concrete.

Justification and Background:

AFRL is interested in studying the mechanical and dynamic properties of a steel cylinder as it undergoes an external quasi-hydrostatic pressure. This research will work in conjunction with a proposed basic research project that the Air Force has currently proposed. A good example of this is driving a pile into sand and then bedrock while still having a portion above exposed. How does the system respond to those changes? Does the cantilever portion behave differently when an end is only in the sand? What about liquefaction of sand during an earthquake? How does that response change the stability of that structure? The same argument can be made when thinking about drill rigs and the pipes that are bored into the earth to access the oil. How does the rest of the system respond to the drilling? Are there stability issues with the free end of the pipe when a portion of it is contained? Your part of this project is to help me develop a way to scientifically determine what type of pressure we are applying to the steel tube. Structural dynamic studies will be performed on the free end of the steel tube to determine their properties under different amounts of pressure applied via this system and at different lengths along the tube. The compressive force should be albe to go up to 10,000 psi.

Methodology:

The first step will be to come up with a material that can withstand the compressive force up to 10,000 psi. The medium needs to be an incompressible material and will be able to transfer the force onto the test section. The next problem to be tackled is how to apply the force and how to measure it without and sensors on the concrete. These are the main two problems that need to be addressed when looking to find a final solution.

Expected Results:

The cylinder that the compressive force is applied to should be 6” in diameter and 24” long. The concrete that will be used shall have a minimum compressive strength of 10,000 psi. The final design should allow AFRL to test pipe sections with different compressive forces. During these dynamic tests they will be able to moniter the conditions of the pipe as well as its perfomance while knowing the force on the pipe.

Constraints:

The design of the cylinder, compressive system, and all aspects of the fabrication should include an evaluation of potential hazards to personnel and to equipment. The design should ultimately incorporate those attributes that minimize risk to personnel and equipment. The cylinder that the compressive force is applied to should be 6” in diameter and 24” long. The concrete that will be used shall have a minimum compressive strength of 10,000 psi.