

Numerical Simulation of an Inflatable Structure Designed to Stop Water Flow in Large Pipes

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ABSTRACT

Current work presents the numerical simulation on an inflatable structure designed to stop a high pressure fluid flow within a pipe. To stop the flow, an inflatable plug must fulfill two main requirements:

1. Seal the pipe section where the structure is installed.
2. Be axially locked in the position where the inflatable is installed.

To seal the pipe section, the inflatable structure must conform perfectly to the pipe internal geometry and must be inflated at a pressure larger than the pressure found in the pipe. To axially lock the plug inside the pipe, the inflatable structure designed relies in the friction developed between the inflatable and the pipe walls. Both conditions require a perfect contact of the plug and the pipe walls. To ensure this contact along the entire perimeter, the cross section of the inflatable structure is designed to be slightly larger than the pipe cross section.

A correct simulation of an inflatable structure requires using the exact geometry of the inflatable, as an excess or lack of fabric may provide a different stress pattern. If the inflatable plug and the pipe are simulated with their exact geometry, in current application the plug has to be larger than the pipe. Therefore, the simulation at hand consists of inflating an element, which has to be contained inside another one, but in which the element to be contained (the plug) is larger than the containing element (the pipe).

To solve this problem current work proposes a modeling strategy based on defining the plug and the pipe with their real geometries, and to apply a displacement to the plug to “fold” it until it is completely contained inside the pipe. Finally, contact between the plug and the tunnel is activated and the plug is inflated until it reaches its final configuration.

Results obtained from the simulation show the validity of the solution proposed to stop water flow in large pipes, as well as the dependence of this sort of structure in the inflation process (an incorrect inflation may lead to the structural failure).

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