

Abstract

A reduced-order model (ROM) was developed for the electrohydraulic pulsed fracturing (EHPF) of concrete. The rationale of the model development is to overcome the shortcomings posed by lab experiments and high fidelity computer simulations. EHPF experiments are costly, time consuming and involve safety risks, while high fidelity simulations are computationally expensive and may include unnecessary details. A ROM model will allow for quick and adequate evaluation of fracturing problems with reduced need for experiments and simulations.

In an EHPF process, a current impulse is discharged through an electrode gap immersed in water, ionizing the liquid to high temperature plasma. The process produces a pulse amplitude that exceeds the strength of concrete, fracturing it. The EHPF model is split in two simpler models. The first model is electrohydraulic pulsed discharge (EHPD) in an underwater reservoir, where the inputs are discharge voltage and electrical parameters, and output is impact pressure. The second model is the fracturing of concrete, where the inputs are impact pressure and material properties, and the outputs is fracture lengths. The EHPD and fracture sub-models are coupled through the impact pressure. Predictive and diagnostic equations for both models were developed and validated.

The validated EHPD model generated a pressure plot of the discharge that is in good agreement with experimental results. Applying this pressure to the validated concrete damage model gave a predicted crack length that is close to the experimental result. These simulated results validate ROM.