Hydraulic fracture oscillations in response to strong impulse

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Hydraulic fractures and the natural fractures in rock masses are closed by the in-situ compressive stress such that their opposite faces are in contact either with each other or with the proppant in hydraulic fractures or with gouge in the natural fractures. Subsequently, a pressure increase can produce negligible deformation in already closed fractures as compared to the deformation associated with the opening caused by sufficiently large tensile stress. This suggests a simple model of closed fracture as a bilinear spring with a certain stiffness in tension and a very high (potentially infinite) stiffness in compression. Therefore the oscillations of fractures can be reduced to the oscillations of a bilinear oscillator or impact oscillator [1] when the compressive stiffness considerably exceeds the tensile one. We use the simplest model of the impact oscillator with preload representing the action of the in-situ compressive stress. Based on this model, two sets of multiple resonances are identified and the reaction to impulsive load is determined. The harmonics of free oscillations are calculated. The knowledge of the first two harmonics is sufficient to recover the tensile stiffness and hence identify the geometric parameters of the fracture. The results of the research contribute to the development of the methods of fracture reconstruction and the hydraulic fracture monitoring.


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