Simulation and analysis of seismic wave propagation at vertex singularities

The main target

The proposed research is targeted to simulate and analyze abnormality of propagation of seismic waves at vertices of the inclined layers, where they face the Earth surface; see, Fig.1.

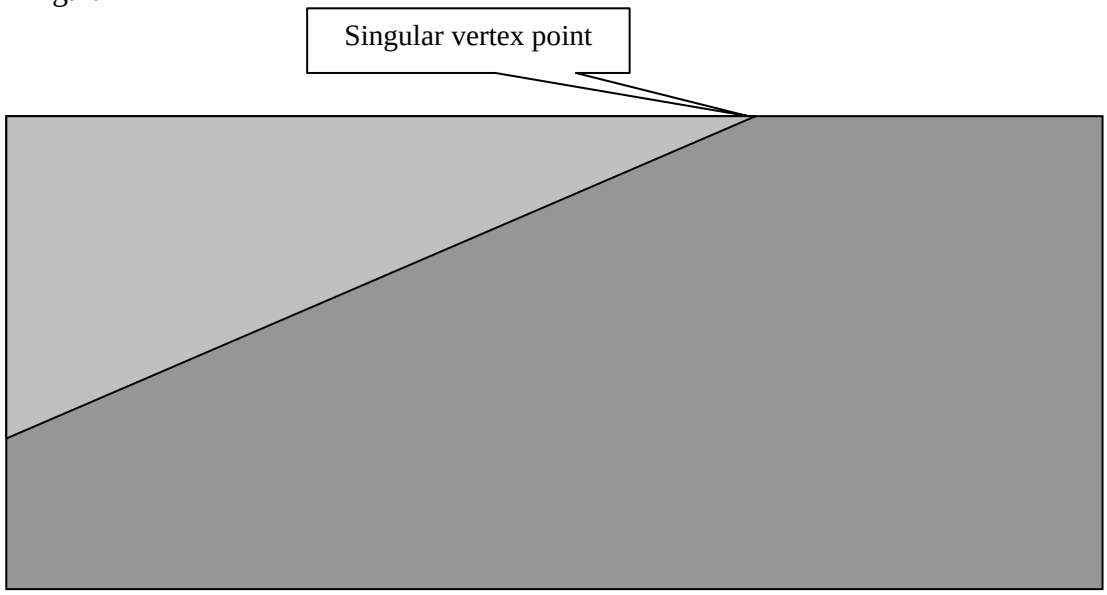

Fig. 1. Plane model for analyzing vertex singularity

Other objectives

Along with the main target, the following problems of great practical importance, will be analyzed:

- Study of focusing effects for different kinds of seismic waves, namely, Rayleigh, Love, and Rayleigh-Lamb waves.
- Analyzing scattering of the seismic wave energy by vertices and finding correlation between frequencies of the waves, physical and geometrical properties of the contacting layers with the amount of the scattered energy.
- Performing the 3D simulations of focusing and scattering of the seismic waves by the cone-singularities.
- Providing comparative analyses of effectiveness of different FEM computer codes for solving problems of seismic wave propagation at singular points.
- Performing simulation of the seismic wave propagation for a real multilayered geological structure; see, Fig.2.

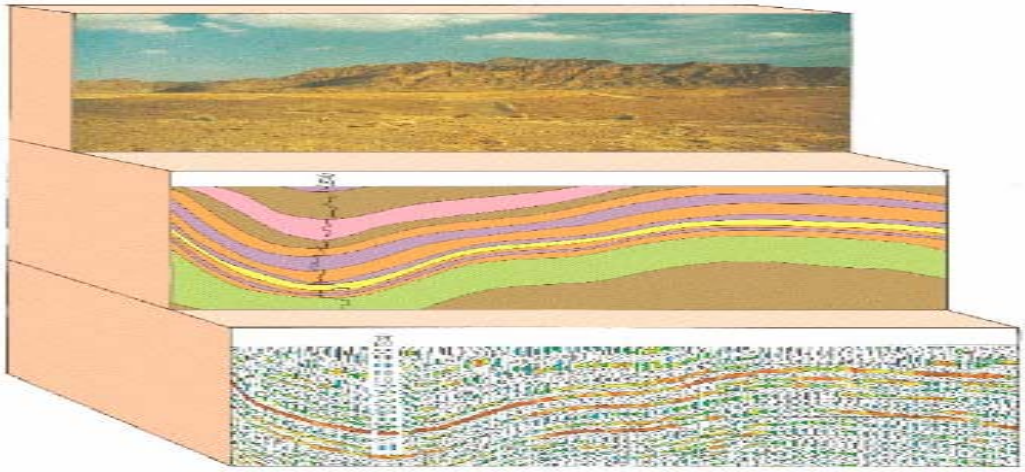

Fig.2. A sample for the real geometrical profile

Plan
of the project

1. Introduction
    a. Actuality of the problem
    b. The main target and other objectives/goals
    c. Brief review of the thesis
2. Literature review
    a. Works in seismic
    b. Works in surface acoustic waves
    c. Works in finite element methods on non-stationary dynamics
3. Classification and theory of seismic waves
    a. Basic notations
    b. Bulk waves
    c. Rayleigh waves
    d. Stoneley waves
    e. Love waves
    f. Lamb and Rayleigh-Lamb waves
4. Methods and principles of numerical simulation in non-stationary dynamics
    a. Basic notations
    b. Explicit and implicit time-difference schemes
    c. Different elements and the corresponding stiffness matrices
    d. Sample problem studies
        i. Propagation of plane harmonic waves
        ii. Propagation of the wave front
        iii. Comparative analysis of different FEM codes
    e. Concluding remarks
5. Study of seismic wave propagation, focusing and scattering by vertex singularities
    a. Plane problems analyses (Rayleigh and Rayleigh-Lamb waves)
        i. Influence of the wedge opening angle on focusing and scattering
        ii. Influence of mechanical properties of the contacting media
        iii. Influence of the wave frequency
    b. 3D problems analyses (Love waves)
        i. Influence of the wedge opening angle on focusing and scattering
        ii. Influence of mechanical properties of the contacting media
        iii. Influence of the wave frequency
    c. Concluding remarks
6. Simulating seismic wave propagation in real geological profiles
    a. Plane problem (Rayleigh and Rayleigh-Lamb waves)
        i. Modeling a real geological profile
        ii. Analyzing propagation and focusing at vertices
    b. 3D problem (Love waves)
    c. Concluding remarks
7. Conclusions and remarks on future studies
    a. Overall conclusions
        i. What the comparative numerical analysis of FEM codes revealed
        ii. The principle physical effects that were observed
        iii. Seismically dangerous regions found at the real geological profile simulation
    b. Remarks on future studies