Contents

Introduction **15**

1 Concepts of Finite Difference Modeling **19**
1.1 Stability of a System 21
1.2 Numerical Dispersion 22
1.3 Staggered Grids and Accuracy of the System 22
1.4 Lateral and Bottom Boundaries 23
1.5 Free-Surface Boundary-Condition 24
1.6 Implementation of the Source 25
1.6.1 Kinematic Ruptures 25
1.6.2 Dynamic Ruptures 28

2 Case Study I: Rhinegraben-Earthquakes **31**
2.1 Motivation 31
2.2 Upper Rhinegraben 32
2.2.1 Tectonics and Geology 32
2.2.2 Seismicity 33
2.2.3 Three Rhinegraben Earthquakes (M_L 3.5 – 3.6) 33
2.3 Modeling Parameters 35
2.3.1 Elastic Model and Geometry 35
2.3.2 Computational Parameters 37
2.4 Numerical Results 38
2.4.1 Arrival Times of P-Waves 39
2.4.2 Peak Ground Velocities 40
2.4.3 Amplitude Ratios 42
2.4.4 Duration of Shaking 44
2.4.5 Response Spectra 44
2.5 Discussion 45

3 Case Study II: The 1927 Jericho Earthquake 51
3.1 Motivation . . . 51
3.2 Dead Sea Rift Transform Fault . . . 52
3.2.1 Tectonics and Geology . . . 52
3.2.2 Seismicity . . . 52
3.2.3 The 1927 Jericho Earthquake . . . 52
3.3 Modeling Parameters . . . 54
3.3.1 Elastic Model and Geometry . . . 54
3.3.2 Computational Parameters . . . 55
3.4 Numerical Results . . . 56
3.4.1 Snapshots of the Wavefield . . . 56
3.4.2 Seismograms . . . 57
3.4.3 Peak Ground Velocities . . . 58
3.4.4 Spectral Accelerations . . . 59
3.5 Discussion . . . 62

4 Case Study III: Earthquakes on Dipping Faults 65
4.1 Motivation . . . 65
4.2 Modeling Parameters . . . 67
4.2.1 Elastic Model and Geometry . . . 67
4.2.2 Dynamic Computational Parameters . . . 67
4.2.3 Kinematic Computational Parameters . . . 69
4.3 Numerical Results . . . 70
4.3.1 Uniform Halfspace (UHS) Model . . . 70
4.3.2 Layered Model, 45^o Dipping Thrust Fault . . . 75
4.3.3 Variation of Initial Stress Distribution . . . 79
4.3.4 Deeper Versus Shallower Events . . . 86
4.4 Discussion . . . 87

Summary 89

A Free-Surface Boundary-Condition 95
A.1 Explicit Free-Surface Boundary-Condition . . . 96
A.1.1 Free-Surface Boundary-Condition FS1 . . . 96
A.1.2 Free-Surface Boundary-Condition FS2 . . . 97
A.2 Source and Receiver Configuration and Model Description . . . 98
A.3 Numerical Results . . . 99

A.3.1 Comparison Between FS1 and FS2 99
A.3.2 Refinement of FS1 and FS2 101

Bibliography **105**

Acknowledgements **119**

Lebenslauf **121**