SIMULATIUON OF SEISMIC ACTION FOR TBILISI CITY WITH LOCAL SEISMOLOGICAL PARTICULARITIES AND SITE EFFECTS

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OUTLINE

- **Introduction**
- **Stochastic Simulation of Earthquake Ground Motion**
- **Parameters Estimation**
- **Determination of Multilayer Ground Motion Based on the Theory of Multiple Reflected Waves**
- **Simulation Results for Tbilisi City Sites**
- **Conclusions**

Introduction

- In the Tbilisi area there is lack of records of strong ground motions, in particular, accelerograms. During the last 100 years at the territory of Tbilisi city about hundred weak earthquakes with intensity 3-5 degree in MSK scale occurred. Local strong earthquake occurred only on April 25, 2002, under the central part on the city with magnitude M=4.5, intensity 7 degree and recorded on the bedrock peak horizontal acceleration of 0.11g.
- When acceleration time–histories are required as the input to engineering design or analysis, three basic options are available:

  - select real accelerograms from strong motion databases;

  - simulate synthetic ground motions from theoretical seismological models of seismic fault rupture;

  - simulate artificial accelerograms from stochastic methods, to match target response spectra (generally used in engineering).

- For this reason to provide the ground motions for dynamic analysis and design in Georgia, the main objective of this study is to simulate the spatial seismic action in terms of accelerograms and corresponding response spectra.

- The proposed methodology includes three main topics:

(i) the stochastic simulation of earthquake ground motion at a given site of the city of Tbilisi;

(ii) estimation of acceleration time histories at a given site of the city of Tbilisi using the direct method of engineering seismology based on the theory of the reflected waves;

(iii) calculation of the horizontal and vertical acceleration elastic response spectra and corresponding the spectral dynamic coefficient for main sites of Tbilisi territory considering the regional seismological characteristics and local soil conditions for the site of interest.

Introduction

Normalized acceleration elastic response spectrum - curve of spectral dynamic coefficient for SDOF system with damping value ε

$$\beta_i(T) = \frac{S_{ai}(\omega,\varepsilon)}{\left|A_{g_i\max}\right|}$$

$$\ddot{U}_i(t) + 2\varepsilon\omega\dot{U}_i(t) + \omega^2 U_i(t) = -A_{gi}(t)$$

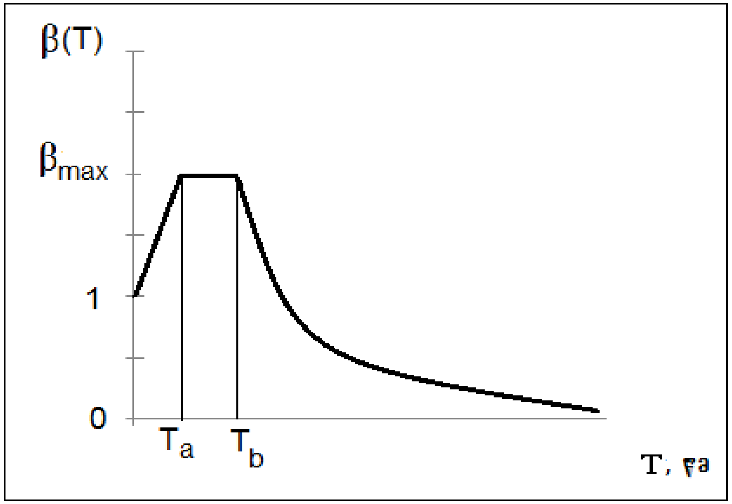
$$i = 1,2,3.$$

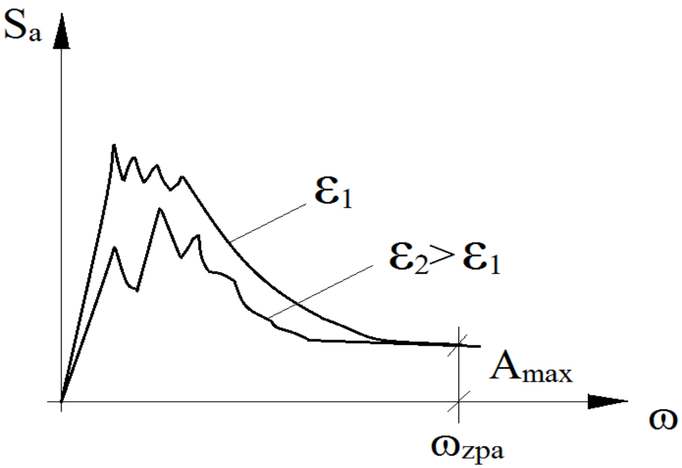
$$\ddot{U}_i(t) = \omega\int_0^t A_{gi}(\tau)\exp[-\varepsilon\omega(t-\tau)\sin\omega(t-\tau)]d\tau$$

$$S_{ai}(\omega,\varepsilon) = \max\left|\ddot{U}_i(t)\right|$$

$$\beta_i(T) = \frac{\tilde{\ddot{U}}_i}{\bar{A}_{gi}}$$

$$\tilde{\ddot{U}}_i = \left[\left(\sum_{j=1}^{m}\ddot{U}_i^2\right)/m\right]^{1/2} \qquad \bar{A}_{gi} = \sqrt{\sum_{j=1}^{n}(A_{gj}^2)/n}$$





- **Eurocode 8 Part-1: General rules, seismic actions and rules for buildings:**

  - the elastic response spectrum shape in the country or part of the country from the certain country National annexes that are worked out by local Authorities.

  - deep geological data of the construction site should be considered and the horizontal and vertical elastic response spectra should be computed taking into account the seismic sources and the earthquake magnitudes generated from them.

- **Georgian Building Code "Earthquake Engineering“ PN 01.01-09:**

  Tbilisi is located in the seismic zone of intensity 8 degree in MSK scale, with a maximum horizontal acceleration equals 0.17g and a return period of earthquakes 2500 years (2%/in 50 years). The spectral dynamic coefficient is determined for grounds of hard (I), medium (II) and soft (III) categories and its maximum value for all three categories grounds equals 2.5.

- From the earthquake sources 8 zones of **Tbilisi region** at the territory of the city there are expected the earthquakes with magnitudes M=5.0 - 7.0 and corresponding seismic generated kinematics of shifting as reverse (N1,2,3,7), reverse with strike slip (N4,5,8) and strike slip(N6) (Fig.1) (**Varazanashvili et al. 2010**)

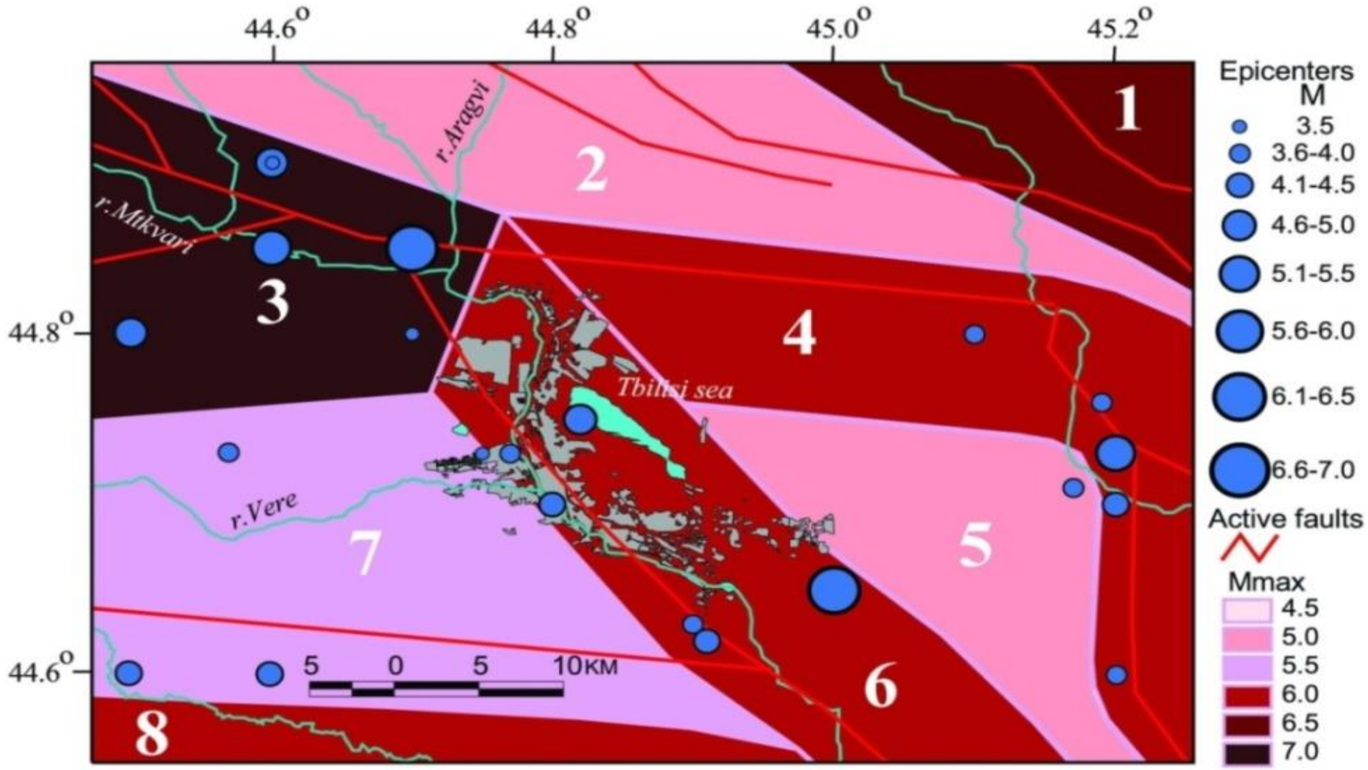


Fig. 1. Earthquake source zones of Tbilisi region

Stochastic Simulation of Earthquake Ground Motion

- For simulation of possible seismic ground motions on the territory of Tbilisi city is employed the discrete nonstationary Gaussian stochastic process represented as **(Rekvava and Mdivani, 2010)**

$$A_{gi}(t) = E_i(t)\, X_i(t) = E_i(t)\, \sigma_i\, x_i(t), \quad (i=1,2,3) \qquad (1)$$

where $A_{gi}(t)$ determines of ground acceleration in the direction of three principal orthogonal axses with zero cross correlation between of components; $E_i(t)$ is the deterministic normalized envelope or modulating function; $X_i(t)$ represents a typical realization of the stationary Gaussian process; σ_i is a mean square value of acceleration in the direction of principal axses and denotes random process intensity that is defined by its variance; i is direction of the axses.

- Normalized stationary random function $x_i(t)$ with zero mean and unit-variance is characterized by $K(\tau)$ function of correlation as

$$K(\tau)=e^{-\alpha_j|\tau|}(\cos\omega_j\tau+\alpha_j/\omega_j\sin\omega_j|\tau|) \qquad (2)$$

- Where α is correlation coefficient characterizing width and configuration of the spectrum of j-th process; ω is circular j-th process frequency; j represents a ordinal number of process .

- The modulating function $E_i(t)$ is defined in terms of so-called Berlag impulse and with $|E_i(t)|_{max}=1$ is given by

$$E_i(t) = \varepsilon\, t \exp(1 - \varepsilon t) \qquad (3)$$

- where ε controls the shape of the envelope function and determines the effective duration and process nonstationarity.

- Generalizing the form in Eq.1, the horizontal and vertical components of the process can be written as

$$\begin{aligned} A_{g1}(t) &= \kappa \sigma_1 \varepsilon t \exp(1-\varepsilon t) x_1(t) \\ A_{g2}(t) &= \eta \sigma_2 \varepsilon t \exp(1-\varepsilon t) x_2(t) \\ A_{g3}(t) &= \upsilon \sigma_3 \varepsilon t \exp(1-\varepsilon t) x_3(t) \end{aligned} \qquad (4)$$

- where k, η and ν are corrective factors of the value of the horizontal and vertical components which are accordingly equal to 1.0, 0.85 and 0.7.

Parameters Estimation

The maximum macroseismic intensity I_{Tb} of the expected earthquake on the territory of Tbilisi city from the earthquake sources zones is defined (**Javakhishvili et al. 1998**)

for small earthquakes ($M_s<6$) $I_{Tb}=1.5M_s-3.4\lg R+3.1$ (5)

for strong earthquakes ($M_s>=6$) $I_{Tb}=1.5M_s-4.7\lg R+4.0$ (6)

- where M_s is surface-wave magnitude; $R=(\Delta^2+h^2)^{1/2}$ is hypocentral distance; Δ is epicentral distance; h-focal depth.

The larger horizontal values of peak horizontal acceleration **(Smit et al. 2000)**

$$\log PGA_{h1}=0.72+0.44M_s-\log R+0.00231K+0.28p \quad (7)$$

$$K=\sqrt{\Delta^2+h^2+4.5^2} \quad (8)$$

- where p is 0 for 50-percentile values and 1for 84-percentile.

The dominant period T of ground motion **(Mikhailova and Aptikaev, 1996)**

$$\lg T=0.15M_s+0.25\lg R+C_1+C_2\pm0.2 \quad (9)$$

Duration of the intesive phase of ground motion is computed by

$$\lg D=0.15M_s+0.50\lg R+C1+C2+C3\pm0.30 \quad (10)$$

- where C_1 – is parameter of fault mechanism; C_2 is parameter of ground category; a mean value of ratio C_3 is equal to 1.3.

Table 1. Quantitative Characteristics of the Predicted Ground Motion on the Borderline of City

Zone N	R (km)	I_{TB} (deg)	T (sec)	D (sec)	PGA_{h1} (m/sec ^{2})	PGA_{h2} (m/sec ^{2})	PGA_{h3} (m/sec ^{2})
From focus with M=5.0							
2	10.5	7	0.13	1.63	2.11	1.65	1.41
5	8.38	7	0.12	1.45	2.20	1.72	1.47
From focus with M=5.5							
7	10.7	8	0.15	2.06	2.38	1.86	1.59
From focus with M=6.0							
4	11.2	8	0.18	2.66	2.53	1.98	1.69
6	10.0	8	0.18	2.51	2.57	2.01	1.72
8	16.0	7	0.2	3.18	2.38	1.86	1.67
From focus with M=6.5							
1	29.4	7	0.28	5.42	2.32	1.81	1.55
From focus with M=7.0							
3	16.3	9	0.28	5.08	2.81	2.20	1.88

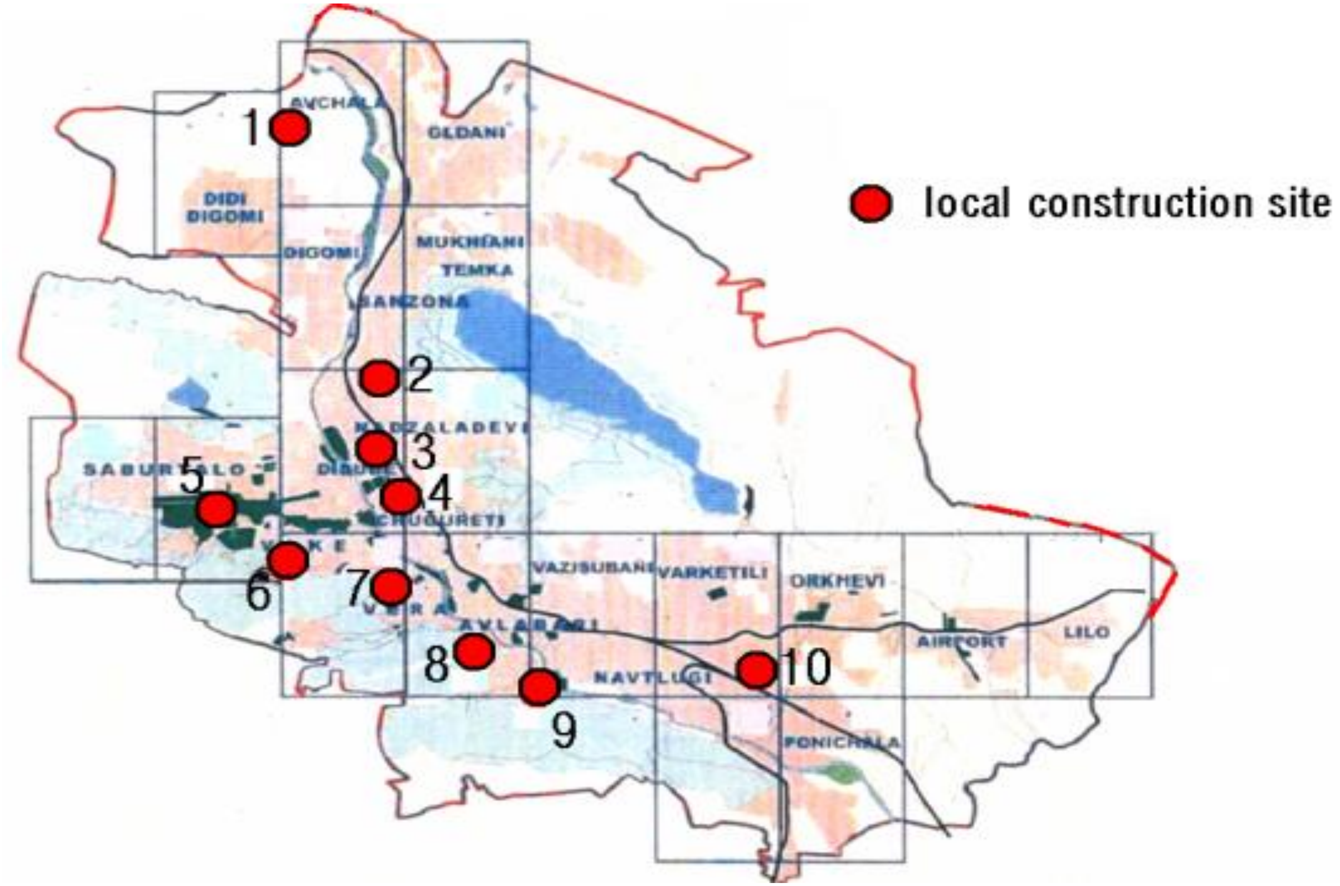


Fig. 2. Location of the sites on the territory of the city

N1, N3, N4, N5, N6, N7 and N10 – II category (medium)
N2, N8 and N9 - III category (soft)

For 10 sites of Tbilisi city territory (350 square kilometers) were determined minimum R, PGA for 2% and 1% probabilities of being exceeded in 50 years, dominant periods and duration of oscillation.

Table 2. **Quantitative Characteristics of the Predicted Ground Motion for the Concrete Sites of Tbilisi City (2%/ in 50 years) generated from the high potential seismic sources zone N3**

Zone №	M	Parameters	Site №									
			1	2	3	4	5	6	7	8	9	10
3	7.0	R_{min}; km	15.6	20.0	21.2	23.3	18.1	21.6	25.1	26.8	30.0	33.7
		PGA_{h1}; m/sec^2	2.83	2.72	2.69	2.65	2.77	2.69	2.62	2.58	2.53	2.47
		PGA_{h2}; m/sec^2	2.21	2.13	2.10	2.07	2.16	2.10	2.04	2.02	1.98	1.93
		PGA_{h3}; m/sec^2	1.89	1.81	1.80	1.77	1.85	1.79	1.74	1.72	1.69	1.65
		T; sec	0.28	0.30	0.30	0.31	0.29	0.305	0.32	0.32	0.33	0.34
		D; sec	4.98	5.63	5.8	6.08	5.35	5.86	6.3	6.52	6.9	7.31

The main parameter ω of the ground motion model is determined based on the Eq.9 using the expression:

$$\omega_j=2\pi/T_j \tag{11}$$

The value of the correlation degree characterizing parameter α is evaluated based on the analysis of the Georgian earthquakes records data depending on ω and for 1(x), 2(y) da 3(z) components consists of

$$\alpha_{j1}=0.204\omega_j; \quad \alpha_{j2}=0.253\omega_j; \quad \alpha_{j3}=0.41\omega_j; \tag{12}$$

The mean square value of acceleration σ was accepted considering that

$$\sigma_i=PGA_i/3, \; i=1,2,3 \tag{13}$$

The parameter ε is determined on the basis of the given duration of intensive oscillations above-mentioned records and is equal to

$$\varepsilon_j = 0.02\omega_j \tag{14}$$

Thus calculated parameters are represented in Table 3.The mean square values of the horizontal and vertical accelerations for earthquake generated from the high potential seismic sources zone N3 are given in Table 4.

Table 3. Parameters for Generation Regional Synthetic Accelerograms

Zone N	ω_j (sec^{-1})	α_{j1} (sec^{-1})	α_{j2} (sec^{-1})	α_{j3} (sec^{-1})	ε_j (sec^{-1})	$\Delta t=0.04T_j$ (sec)	
From focus with M=5.0							
2	48.3	9.85	12.1	19.8	0.97	0.005	
5	52.3	10.67	13.1	21.4	1.05	0.0048	
From focus with M=5.5							
7	41.8	8.53	10.5	17.1	0.84	0.006	
From focus with M=6.0							
4	34.8	7.1	8.7	14.3	0.7	0.007	
6	34.8	7.1	8.7	14.3	0.7	0.007	
8	31.4	6.4	7.9	12.9	0.63	0.008	
From focus with M=6.5							
1	22.4	4.5	5.6	9.2	0.45	0.011	
From focus with M=7.0							
3	22.4	4.6	5.6	9.2	0.45	0.011	

Table 4. Mean Square Values of Aaccelerations for Concrete Sites from seismic source zone N3

Mean square value of acceleration m/sec^2	Probability of exceeding in 50 years	Site #									
		1	2	3	4	5	6	7	8	9	10
σ_1	2% /50	94	91	90	88	92	90	87	84	84	82
	1% /50	109	104	103	102	106	103	100	97	97	95
σ_2	2% /50	73	71	70	69	72	70	68	67	66	64
	1% /50	85	81	81	79	83	80	78	77	76	74
σ_3	2% /50	63	60	60	59	62	60	58	57	56	55
	1% /50	72	70	69	68	71	69	67	66	65	63

Determination of Multilayer Ground Motion Based on the Theory of Multiple Reflected Waves

It is assumed that the ground is elastic and waves are propagated in the vertical direction (Fig. 3). In the form of seismic influence in this case is used recorded on the bedrock accelerogram from the database of ground motions with known earthquake.

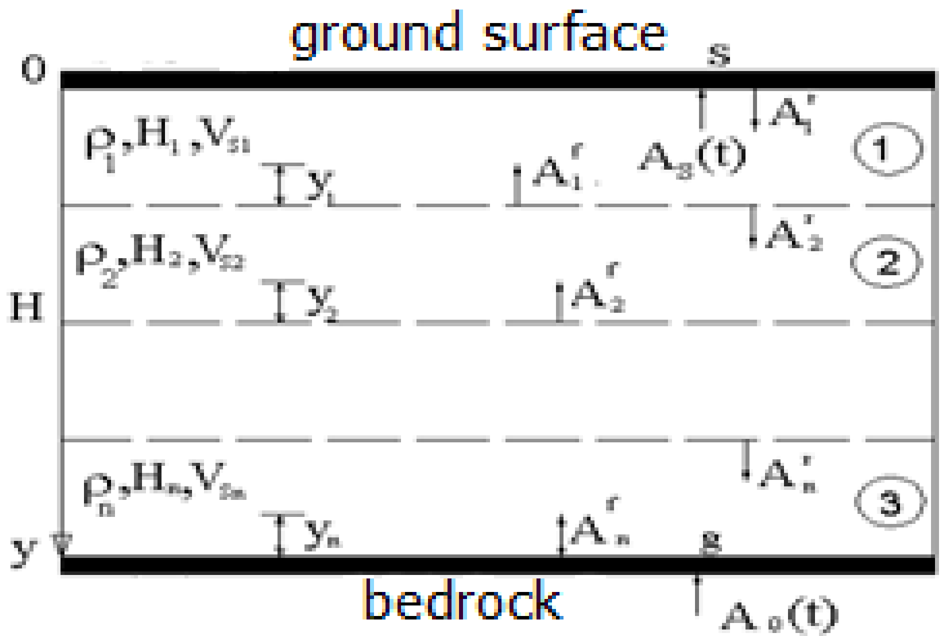


Fig. 3. Design model of non-homogeneous ground

In the Fig. 3 are accepted following designations: $A_i^f(t)$ is value of the wave function at the t time on the bottom level of the i-th layer;

$A_i^r(t)$ is value of the wave function at the *t* time on the top level of the i-th layer;

$A_0(t)$ is given relationship of the movement on the level of bedrock.

For any i-th layer of ground the wave equation of shear oscillations can be written as **(Napetvaridze, 1973)** :

$$\frac{\partial^2 A_i(t)}{\partial t^2} - V_{si}^2 \frac{\partial^2 A_i(t)}{\partial y^2} = 0 \qquad (15)$$

- where $A_i(t)$ is the displacement of ground layer particles; t is the time; y represents the coordinate of particle oscillation in the vertical direction; V_s is the velocity of the shear wave propagation in the ground area.

Solution of the equation (15) on the top of the i-th layer at the t time is given by

$$A_i^r(t) = \alpha_{i-1,i} A_{i-1}^r(t - \tau_{i-1}) + \beta_{i,i-1} A_i^f(t - \tau_i) \qquad (16)$$

- where $\alpha_{i-1,i}$ is the factor of refraction under passing of wave from i-1-th to i-th layer; $\beta_{i,i-1}$ the factor of wave reflection on the borderline between i and i-1 layers; τ_i represents the time of wave passage in the i-th layer , $\tau_i = H_i/V_{si}$ where H_i and V_{si} are accordingly the thickness of ground layer and the velocity of the shear wave propagation in the i-th layer.

- α and β factors are defined by

$$\alpha_{i-1,i} = 2\rho_{i-1}V_{s,i-1} / \left(\rho_{i-1}V_{s,i-1} + \rho_i V_{si}\right) \qquad (17)$$

$$\beta_{i,i-1} = \left(V_{si}\rho_i - \rho_{i-1}V_{s,i-1}\right) / \left(V_{si}\rho_i + V_{s,i-1}\rho_{i-1}\right) \qquad (18)$$

➢ where ρ_{i} is a density of i -th ground layer.

- Finally solution of the direct problem of engineering seismology can be represented by the recurrent relations as:

$$\begin{aligned}
A_1^r(t) &= A_1^f(t-\tau_1), \\
A_1^f(t) &= \alpha_{2,1}A_2^f(t-\tau_2) + \beta_{1,2}A_1^r(t-\tau_1), \\
A_2^r(t) &= \alpha_{2,1}A_1^r(t-\tau_1) + \beta_{2,1}A_2^f(t-\tau_2), \\
A_2^f(t) &= \alpha_{3,2}A_3^f(t-\tau_3) + \beta_{2,3}A_2^r(t-\tau_2), \\
A_i^r(t) &= \alpha_{i-1,i}A_{i-1}^r(t-\tau_{i-1}) + \beta_{i,i-1}A_i^f(t-\tau_i), \\
A_i^f(t) &= \alpha_{i+1,i}A_{i+1}^r(t-\tau_{i+1}) + \beta_{i,i+1}A_i^r(t-\tau_i), \\
A_n^r(t) &= \alpha_{n-1,n}A_{n-1}^r(t-\tau_{n-1}) + \beta_{n,n-1}A_n^f(t-\tau_n), \\
A_n^f(t) &= \alpha_{n+1,n}A_0(t) + \beta_{n,n+1}A_n^r(t-\tau_n).
\end{aligned} \qquad (19)$$

- Oscillation of the particles from the bottom of i-th layer on the level of y_i can be calculated according to (Napetvaridze, 1973)

$$A_i^{y_i}(t) = A_i^f\left(t - y_i / V_{si}\right) + A_i^r\left(t - \left(H_i - y_i\right) / V_{si}\right) \qquad (20)$$

Simulation Results for Tbilisi City Sites

- The developed software ACCSIM was used for generation of the horizontal and vertical components of synthetic accelerograms corresponding possible seismic source zones of Tbilisi region, given in Table 1.

- When assessing the probabilistic mean elastic response spectra and the normalized dynamic coefficient spectral curves for all sites, which are presented in Fig.2, the required number of realizations was reduced for each synthetic accelerogram up to 20 realizations.

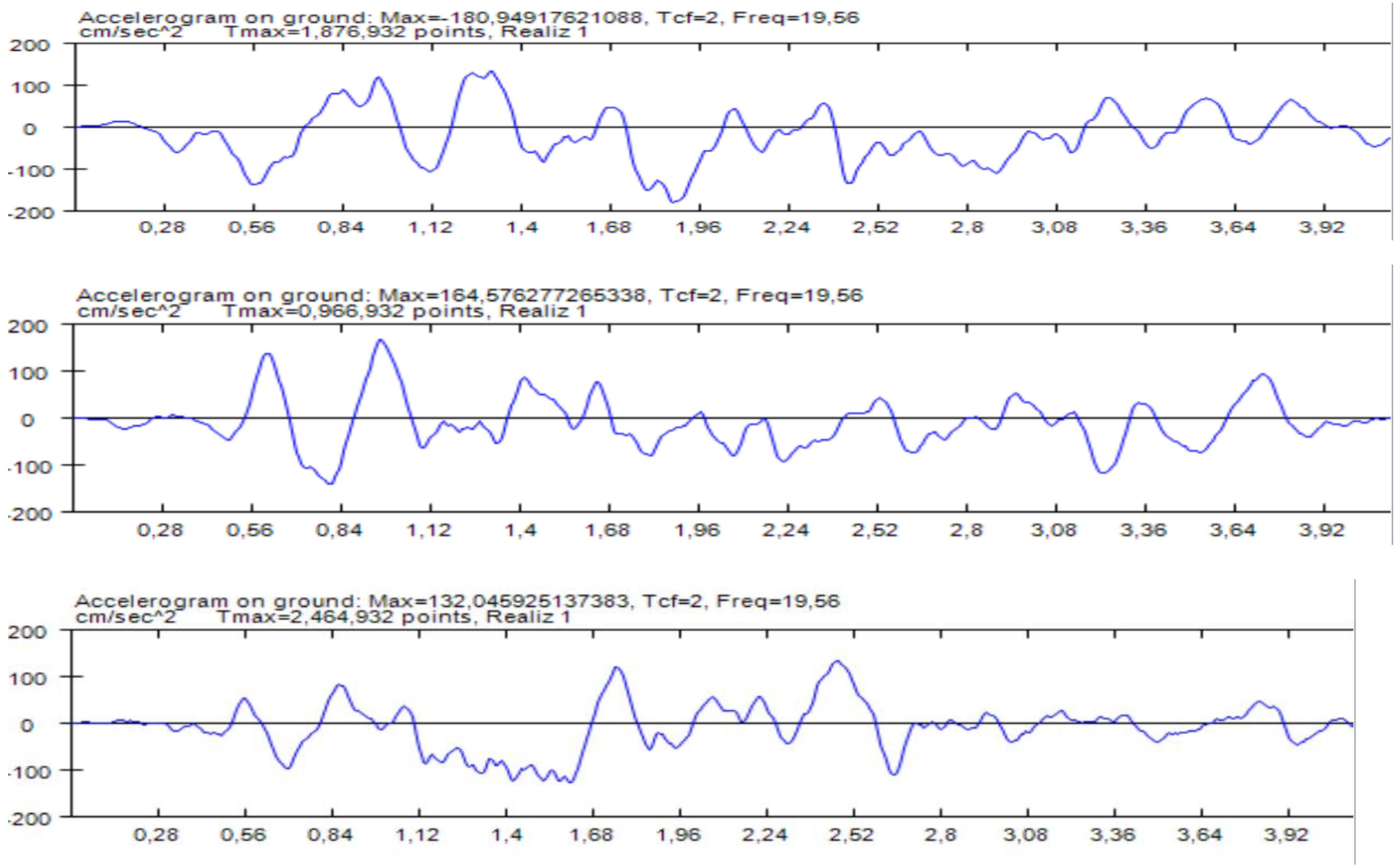


Fig. 4. Three components of accelerogram generated from zone 3 on the free ground of the site 8

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Table 5. Design parameters of probabilistic dynamic coefficient (2 %/in 50years)

Zone #	Magnitude	Components	Site																	
			N1			N2			N5			N7			N8			N10		
			β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b
3	7.0	x	2.5	0.2	0.4	2.4	0.16	0.4	2.5	0.2	0.4	2.4	0.3	0.5	2.5	0.3	0.5	2.4	0.2	0.4
		y	1.8	0.15	0.4	2.0	0.1	0.3	2.6	0.15	0.35	2.2	0.2	0.4	2.5	0.2	0.4	2.5	0.15	0.4
		z	2.2	0.2	0.5	2.7	0.2	0.5	1.8	0.2	0.4	2.1	0.2	0.4	2.6	0.15	0.35	1.8	0.2	0.4
6	6.0	x	2.6	0.2	0.4	2.0	0.1	0.3	3.0	0.1	0.3	2.35	0.2	0.4	2.6	0.1	0.3	2.3	0.15	0.35
		y	2.5	0.2	0.5	2.0	0.1	0.3	2.5	0.1	0.3	2.2	0.1	0.3	2.5	0.1	0.3	2.3	0.15	0.35
		z	3.0	0.15	0.35	2.5	0.1	0.3	2.7	0.15	0.4	3.25	0.15	0.4	2.5	0.1	0.35	2.0	0.15	0.35

Table 6. Design parameters of probabilistic dynamic coefficient (1%/in 50years)

Zone #	Magnitude	Components	Site																	
			N1			N2			N5			N7			N8			N10		
			β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b
3	7.0	x	2.7	0.15	0.35	2.5	0.15	0.35	2.8	0.15	0.35	3.0	0.2	0.4	3.0	0.2	0.4	2.6	0.2	0.4
		y	2.2	0.15	0.4	2.4	0.1	0.35	3.0	0.1	0.3	2.6	0.2	0.3	2.5	0.15	0.3	2.7	0.15	0.4
		z	3.0	0.15	0.35	3.0	0.2	0.5	3.0	0.1	0.3	2.2	0.2	0.4	2.8	0.1	0.35	2.3	0.2	0.4
6	6.0	x	3.0	0.2	0.35	2.9	0.1	0.3	3.7	0.1	0.3	2.5	0.25	0.4	3.2	0.1	0.3	2.5	0.15	0.35
		y	2.7	0.2	0.4	2.5	0.1	0.3	3.0	0.1	0.3	2.5	0.1	0.3	30	0.1	0.3	2.5	0.15	0.35
		z	3.4	0.15	0.35	2.7	0.1	0.3	0.3	0.2	0.4	3.5	0.3	0.4	2.8	0.1	0.35	2.5	0.15	0.35

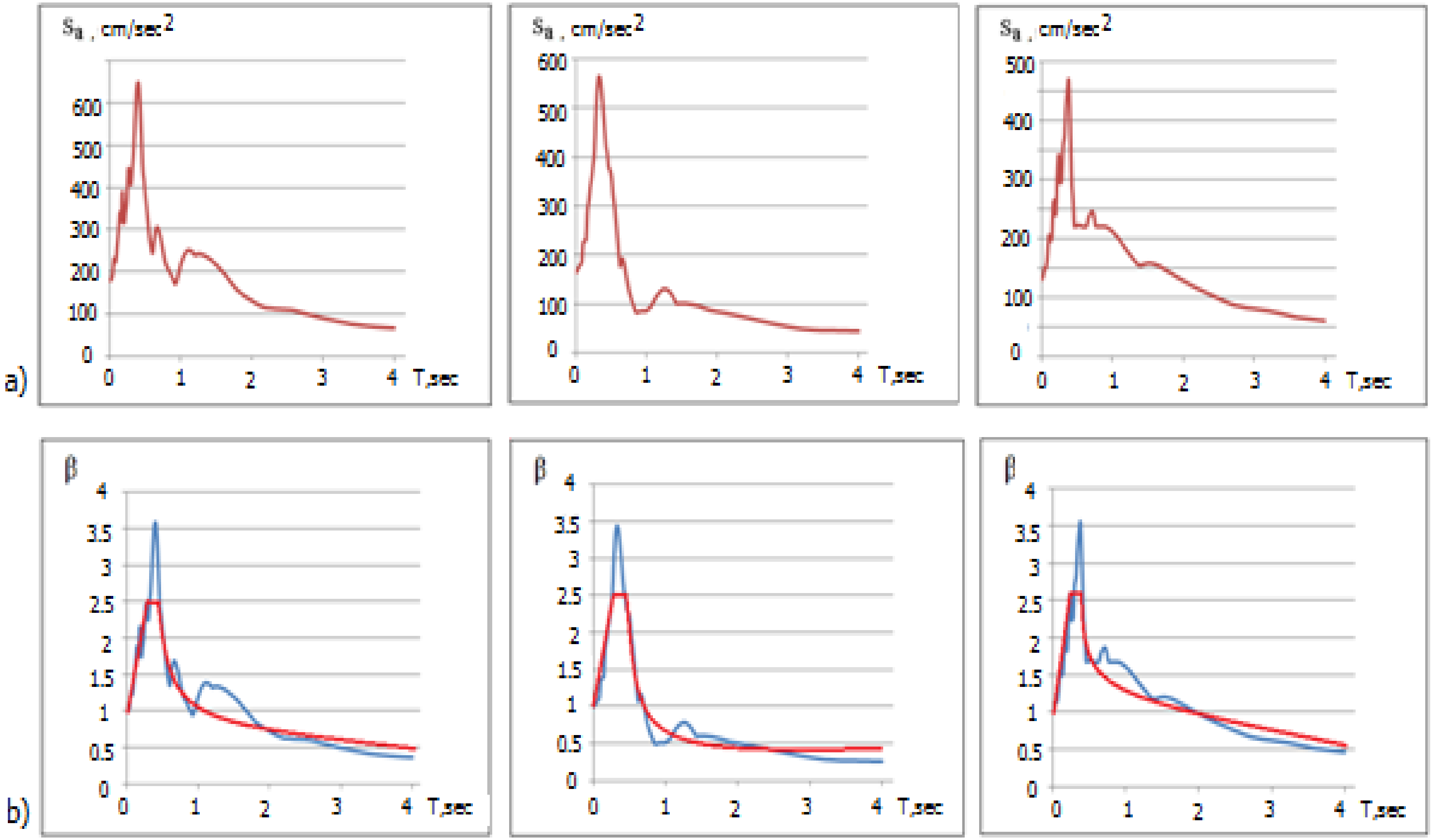


Fig. 5. Generated from seismic sources zone #3 for site #8 x,y,z components of acceleration response spectra (a) and spectral curves of dynamic coefficient (2%/ in 50 years) (b)

- Using the software GAFART was studied an influence of a typical earthquake and local soil conditions upon forming the acceleration elastic response spectra for the abovementioned sites.

- The data set was selected five recorded on the bedrock accelerograms :

- **EL Centro-1940-M=6.7, T=0.85 sec D=29.2 sec,**
- **Santa Barbara-1980-M=6, T=0.4 sec, D=4.02sec,**
- **Montenegro-1979-M=7, T=0.5, D=21.3 sec,**
- **Friuli 1976-M=6, T=0.23, D=8.88 sec**
- **Tbilisi-2002- M=4.5, T=0.2 sec, D=9.8 sec**,

- Accelerograms are different from each other by parameters of PGA (0.144g, 0.146g, 0.21g, 0.62g, 0.11g) dominant period (T) and duration (D), but by the magnitude and epicentral distance are close to predictable earthquakes characteristics for Tbilisi region.

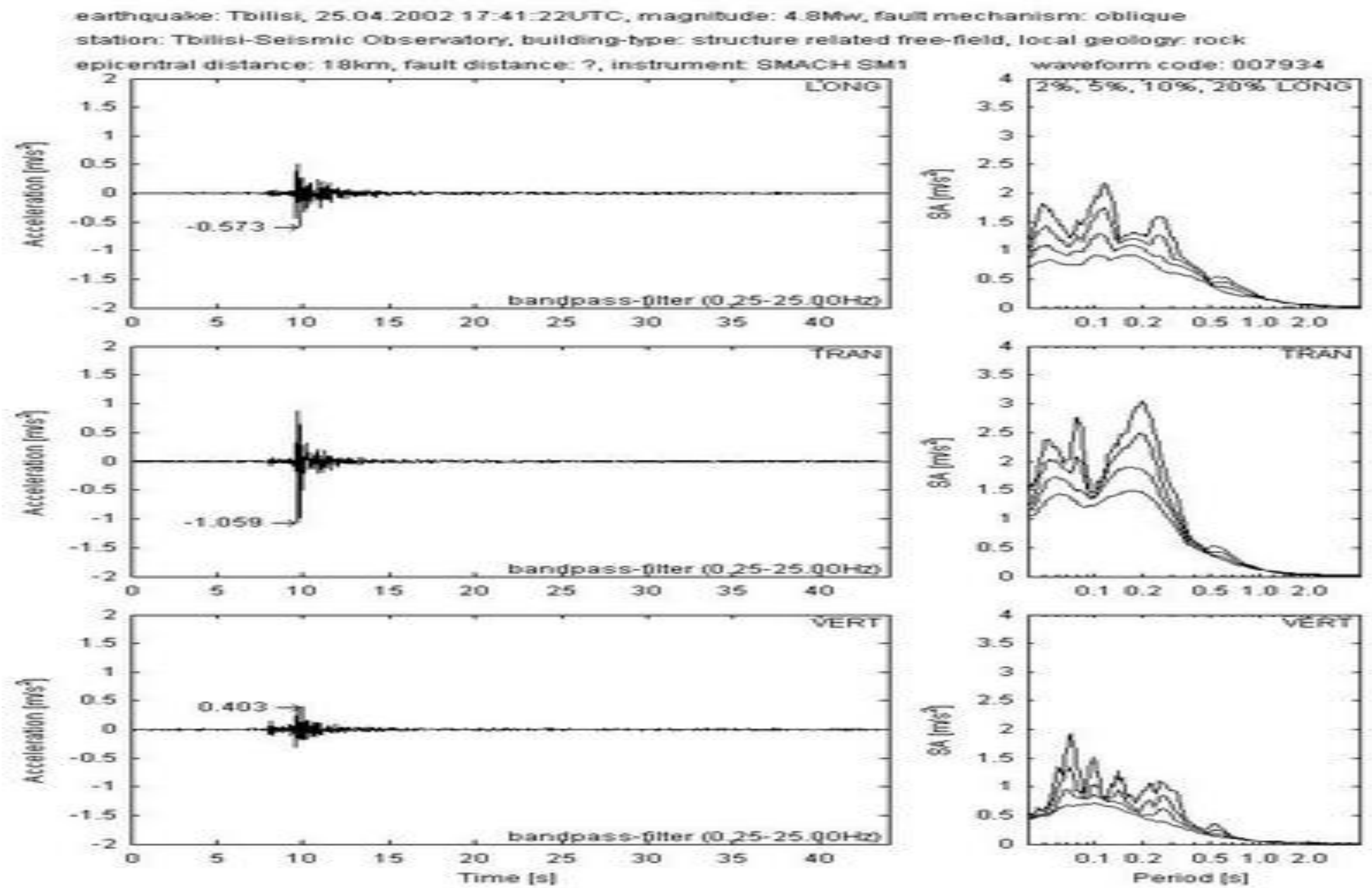


Fig.6. Three components accelerogram of Tbilisi (25 April 2002) earthquake recorded on the bedrock

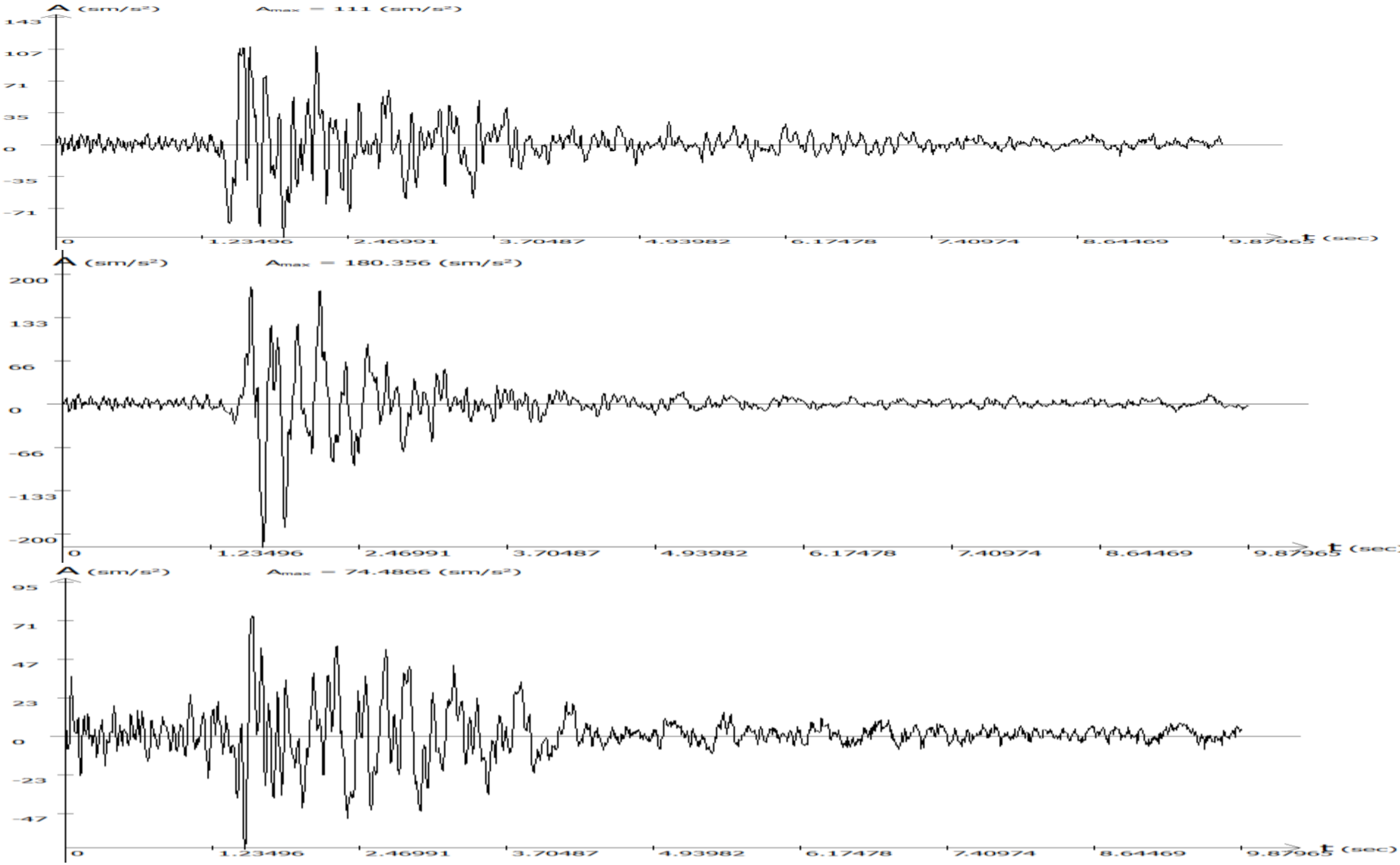
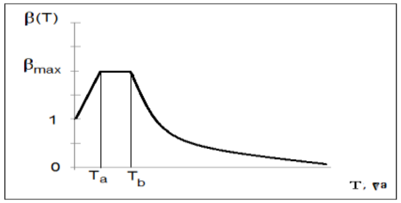


Fig.7. Three components accelerograms of Tbilisi (25 April 2002) earthquake calculated at the ground free surface of N8 site from recording accelerograms of the depth -43.1 m

Table 7. Design parameters of dynamic coefficient



N	Title of Accelerogram	components	Site																	
			N1			N2			N5			N7			N8			N 10		
			β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b	β_{max}	T_a	T_b
1	El Centro	x	2.2	0.1	0.3	3.0	0.2	0.4	3.0	0.1	0.3	2.5	0.2	0.4	3.0	0.3	0.6	2.5	0.25	0.4
		y	2.2	0.1	0.3	3.0	0.2	0.4	3.0	0.1	0.3	2.5	0.2	0.4	3.0	0.3	0.6	2.5	0.25	0.4
		z	2.2	0.1	0.3	3.0	0.2	0.4	3.0	0.1	0.3	2.5	0.2	0.4	3.0	0.3	0.6	2.5	0.25	0.4
2	Santa Barbaara	x	2.7	0.2	0.4	3.5	0.3	0.5	4.0	0.25	0.5	3.0	0.25	0.5	2.5	0.2	0.5	2.7	0.2	0.4
		y	2.7	0.2	0.4	3.5	0.3	0.5	4.0	0.25	0.5	3.0	0.25	0.5	2.5	0.2	0.5	2.5	0.2	0.4
		z	2.7	0.2	0.4	3.5	0.3	0.5	4.0	0.25	0.5	3.0	0.25	0.5	2.5	0.2	0.5	2.4	0.2	0.4
3	Montenegro	x	2.5	0.1	0.3	3.5	0.3	0.5	2.5	0.1	0.3	3.0	0.3	0.5	4.0	0.3	0.6	2.5	0.2	0.4
		y	2.0	0.1	0.3	3.0	0.25	0.4	3.0	0.1	0.3	3.7	0.3	0.5	3.0	0.1	0.5	2.5	0.2	0.5
		z	3.0	0.1	0.3	2.5	0.2	0.5	2.7	0.1	0.3	3.0	0.2	0.5	2.0	0.1	0.5	3.0	0.2	0.4
4	Friuli	x	2.4	0.1	0.3	3.0	0.2	0.4	3.5	0.3	0.5	3.0	0.1	0.4	3.0	0.1	0.6	2.8	0.25	0.4
		y	2.7	0.1	0.4	3.3	0.2	0.4	3.0	0.2	0.4	2.8	0.3	0.5	2.5	0.15	0.3	2.7	0.25	0.5
		z	1.8	0.1	0.4	3.0	0.2	0.4	2.3	0.2	0.4	2.3	0.2	0.4	2.5	0.12	0.3	2.5	0.3	0.6
5	Tbilisi	x	2.5	0.1	0.3	2.0	0.1	0.3	2.1	0.15	0.4	2.5	0.15	0.4	2.3	0.05	0.3	2.3	0.15	0.5
		y	2.5	0.1	0.3	2.2	0.1	0.3	3.1	0.25	0.5	2.0	0.15	0.4	2.5	0.1	0.3	2.5	0.2	0.4
		z	2.3	0.1	0.3	2.3	0.1	0.3	2.4	0.2	0.4	3.0	0.2	0.4	2.1	0.1	0.3	2.2	0.1	0.5

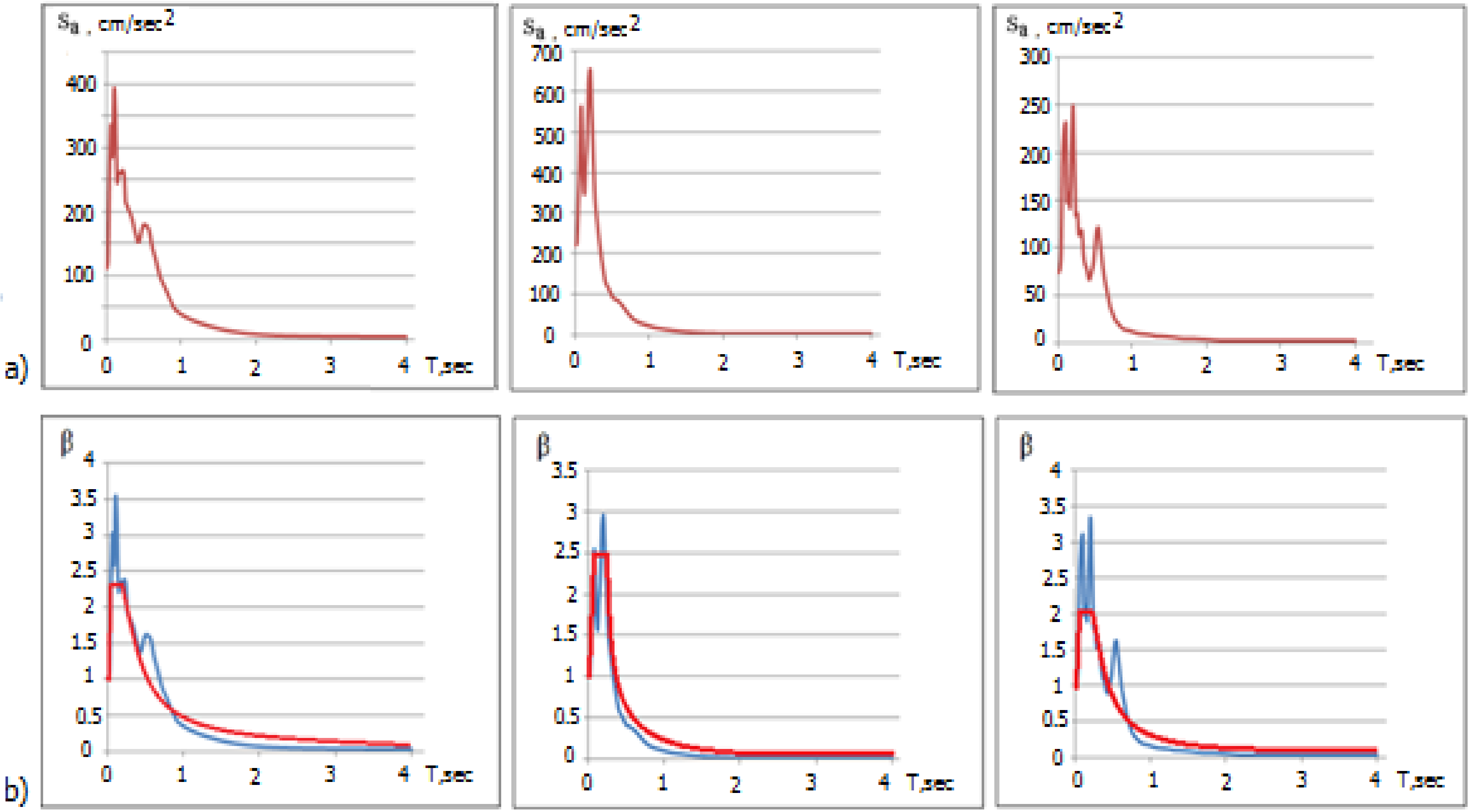


Fig. 8. Three components acceleration response spectra (a) and spectral curves of dynamic coefficient (b) for site #8 resulting from the accelerogram calculated at the free surface from recording "Tbilisi- 2002" of the depth z=-43.1m

CONCLUSIONS

1. The complex approach of simulation ground motion is proposed. The horizontal and vertical elastic response spectra and corresponding dynamic coefficient spectral curves for II and III category of the soil are constructed. This method is accounted for the location of the earthquake sources zones in the Tbilisi region and its characteristics and concrete construction sites conditions of the city.
2. According to the obtained results the value of the amplification factor (ratio of the maximum accelerations of the ground surface layer to the bedrock) in the given soil properties of the sites under investigation are changed from 1.5 to 2.6 due to response of surface soil sediments.
3. The maximum values of dynamic coefficient (2.6-3.0) determined and based on the stochastic ground motion model under medium and soft ground conditions are up to 1.04-1.2 times larger than given in Building code (2.5).
4. The maximum values of dynamic coefficient (2.7-4.0) obtained from the solution of the direct problem of engineering seismology are 1.08-1.6 times grater than determined in Building code (2.5).

Thank You

for your attention