

MAJOR HISTORICAL EARTHQUAKES IN ROMANIA AND CONTEMPORARY SEISMIC RISK MANAGEMENT ACTIVITIES

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Romanian earthquake catalogues (Radu (1974, 1980, 1995), Constantinescu and Marza (1980, 1995) and INFP (2014) contains around 1000yr. of seismic effects evidence of the Vrancea subcrustal source (60 –180km) in Romania.

However the last 2 centuries are by far the best documented as well as the most severe in terms of buildings damage.

The 4 largest subcrustal Vrancea earthquakes in the last 200 years are:

(i) In the 19th century: the 1802 ($M_w = 7.9$) and the 1838 ($M_w = 7.6$) event

(ii) In the 20th century: the 1940 ($M_w = 7.7$, $h = 150$ km) and the 1977 ($M_w = 7.5$, $h = 109$ km)

The 1802 is considered the largest Vrancea earthquake ever felt in Romania, and the 1977 is considered the most severe earthquake in terms of people lost and building damage (World Bank Report 16.P-2240-RO, 1978).

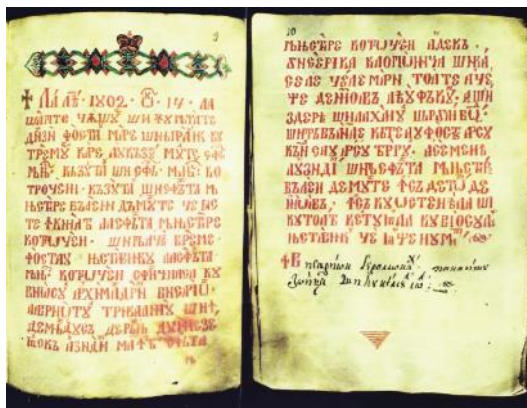


Figure 1. Chronicles of Valeni Monastery (1802 earthquake)



Figure 2. Faculty of Medicine (1977 earthquake)

The list of the buildings collapsed by the 1977 is presented in Table 1.

Examples of the most severely damaged buildings and the existing damage score according to Gulkan et al. (1994) are presented in Table 2.

The distribution of the existing housing units and/or buildings located in seismically vulnerable central Bucharest is condensed in Table 3.

The manifest of the present situation by the central and local authorities is presented and further commented, Table 4.

Table 1. The 31 buildings collapsed in Bucharest on March 4, 1977 (excerpt)

No.	Building	Address	Construction year	Storeys	Occupancy	Housing units	Building structure	Type of collapse
Pre-WWII RC buildings								
1	<i>Belvedere</i>	7, Brezoianu	1938	GF+13S	housing	-	RC frame	total
2	<i>Continental</i>	3, Ion Ghica	1935	GF+10S	"	72	"	"
3	<i>Carpati</i>	5, Academiei	1936	GF+9S	offices	-	"	partial
New RC buildings								
4	<i>OD16</i>	7, Pacii	1974	GF+10S	housing	33	RC shear wall	partial
5	<i>Lizeanu</i>	33, St. cel Mare	1962	GF+9S	"	44	"	"
6	<i>MITC Comp. Center</i>	Garii de Nord	1968	GF+2S	offices	-	RC frame	total

Table 2. Pre-1940 Buildings with more than 5 stories in central Bucharest, registered as having highest risk of collapse in case of strong (similar to '77) earthquake

No	Address	Year of building construction	Commercial occupancy of ground floor	Storeys	No. of apt.	Damages after the 1977 earthquake in structural elements	Repairing work after the 1977 earthquake	SD Damage score
1	Vasile Lascar 26-28	1937	Yes	7	28	Columns : <i>Extreme</i> Beams : <i>Extreme</i> Masonry : -	Masonry Repairs	86
2	Ion Campineanu 9	1915	Yes	7.5	25	Columns : - Beams : - Masonry : <i>Extreme</i>	Masonry Repairs Finishes	77
3	Dionisie Lupu 55	1936	No	6.5	13	Columns : <i>Extreme</i> Beams : <i>Extreme</i> Masonry : <i>Extreme</i>	Jacketing Masonry Repairs Epoxy resins injections	100
4	Calea Victoriei 112	1939	Yes	9	27	Columns : <i>Extreme</i> Beams : <i>Extreme</i> Masonry : <i>Extreme</i>	Jacketing of 4 columns Masonry Repairs Epoxy resins injections	100
5	Lahovari 5A	1935	Yes	8	18	Columns : <i>Extreme</i> Beams : <i>Extreme</i> Masonry : <i>Extreme</i>	Jacketing Masonry Repairs Epoxy resins injections Mortar injections	100

Table 3. Bucharest housing units / buildings by seismic risk classes (excerpt)

	Seismic risk class 1* public danger	Rs 1*	Rs 2
Buildings	190	184	301
Housing units	5.363	1.276	11.070

* 31 building already retrofitted

Table 4. Central Bucharest housing units Public danger, Seismic risk class 1 (excerpt)

No. of storeys	Building age								Total
	<1900	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	>1960	
5 storeys	34	-	-	239	296	31	-	-	600
6 storeys	39	67	33	40	632	-	-	-	811
7 storeys	-	-	25	142	681	30	-	-	878
8 storeys	-	-	-	105	538	134	-	-	777
9 storeys	-	-	-	54	369	52	437	339	1251
10 storeys	-	-	-	-	171	-	156	70	397
>10 storeys	-	-	-	-	74	-	-	-	74

