METHODOLOGY FOR PRELIMINARY ASSESSMENT OF THE CONSEQUENCES OF A STRONG EARTHQUAKE IN ARMENIA

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Summary: *Based on the analysis of statistical data on the effects of the earthquake in Armenia, the authors developped technologies for the express preliminary assessment of the following important parameters of the destruction zone: the boundaries and the most heavily affected settlements; the scale of the destruction of buildings; destruction of main lifelines, human losses. In our opinion, these technologies can also be used for the countries in the territory of the South Caucasus.*

Key words: *assessment, material losses, victims.*

After a strong earthquake, there is an urgent need to carry out preliminary assessment of some important parameters of the destruction zone for the organization of rescue operations. The first stage, concerns the determination of the parameters of the destruction zone, the most affected settlements, the extent of the destruction of buildings, human losses, the areas of damaged main lifelines [2,4,6,]**.** The methods developped are based on the statistical data on the consequences and effects of strong earthquakes in Armenia and on the results of analysis of these data.

Determination of the area of destruction and the most heavily affected settlements.

Problem is implemented on the basis of coordinates of the epicenter, magnitude and isoseist models. Based on the analysis of the isoseist maps of 14 earthquakes in the territory of Armenia with an intensity of 6 or more by EMS-98 scale, the average and maximum radii of the isoseist models of earthquakes with an intensity of 9 and 10 t are calculated (table 1).

Table 1. Maximum and average radii of statistical models of the isoseist of strong earthquakes in the territory of Armenia [5,6].

Earthquake intensity at the epicenter	Isoseists axis	Maximum and average radii of isoseist axes in km					
		10		**9**		**8**	
		Max.	Mav.	Max.	Mav.	Max.	Mav.
10	Large	27	**20**	100	**48**	130	**63**
	Small	10	**6**	35	**18**	65	**30**
9	Large	-	**-**	13	**9**	20	**22**
	Small	-	**-**	5	**4**	10	**15**

The scale of the destruction of the buildings.

The 1988 Spitak earthquake caused noticeable damage to buildings located in the zone of intensities higher than 7(by EMS-98). Large-scale destruction was determined by the 8-9 and greater intensity

shaking) [3,7]. More than 50% of residential areas were destroyed in the 9-intensity zone, and 100% in the 10-intensity zone. The most likely destruction included: multi-storey (5 and more) residential buildings, public buildings (educational, health, department stores), buildings of factories build in 1957-1991(Soviet period) [3,5]. Damages to 1-2-storey private stone houses built with concrete mortar were relatively low even in the 9-intensity zone. Among the state-sector constructions, 9-storey frame buildings appeared the most vulnerable: 85% of those buildings collapsed immediately after the intensity 9 shaking, and the remaining 15% became unsuitable for rehabilitation. The 9-storey large-panel buildings withstood the same intensity shaking, and had damages of Categories 1 or 2. Taking into consideration the earthquake damage statistics for different types of buildings within the same intensity zone, specialists of the Seismic Survey of the MES of the Republic of Armenia compiled diagrams of damage of five common types of buildings in the earthquake zone depending on the earthquake intensity (figure # 1). This is a very important data for seismic vulnerability assessment of multi-apartment buildings, as in practice other methods and calculations cannot offer a reliable assessment of the seismic vulnerability of poorly constructed buildings.

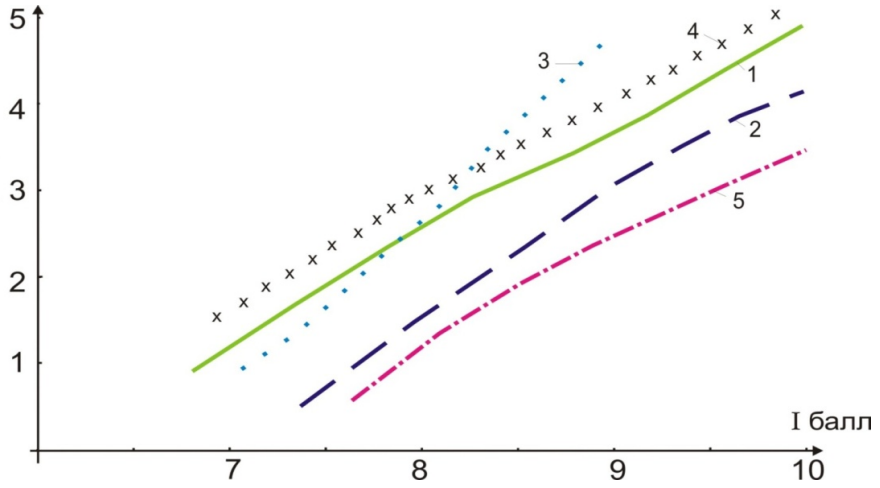

Fig. 1. Damage statistics data for various types of residential buildings in the 1988 Spitak earthquake depending on seismic intensity) [3,5]. Type of buildings: 1-Stone 1-2 storey buildings with sand-clay and lime mortar without metal; 2-stone 1-2 storey buildings with concrete mortar and metal; 3- frame-panel 4-12-storey buildings; 4- stone 4-5 storey buildings of series 450 and 451; 5-Large - panel multi-storey buildings.

Destruction of lifelines.

Urban infrastructure is significantly damaged, from the intensity 8 EMC-98. Railways and highways, gas pipelines, high-Voltage lines, and water supply lines are damaged from the intensity 9 (table 2). Possible damage of external lifelines ar given in table 3:

Table 2. Estimated data on damages to the infrastructure caused by earthquake intensity of 8-10 by EMS-98 scale [5].

N	Infrastructure elements	Damage level at earthquake intensity by EMS-98		
		8	9	10
1	Water lines	weak	average	strong
2	Sewer lines	weak	average	strong
3	Power cables (10 000-30 000 V)	average	strong	strong
4	Medium pressure gas lines	average	strong	strong
5	Cables of Telephone lines	average	strong	strong
6	Streets	average	strong	strong

Table 3. Estimated data on damages to the external lifelines caused by the earthquake intensity of 8-10 by EMS-98 scale [5].

N	Lifelines	Damage level at earthquake intensity by EMS-98		
		8	9	10
1	Water pipes	weak	average	strong
2	Sewer lines	weak	average	strong
3	High Voltage Power Lines	weak	average	strong
4	Gas supply pipelines	weak	strong	strong
5	Cable telecommunication lines	weak	strong	strong
6	Railways	weak	weak	average
7	Highways	weak	weak	average

Assessment of human losses.

The number of earthquake victims depends on many factors. The most important are: number of destroyed buildings, time and season of the year, rescue potential, public preparedness, degree of preparedness of the local authorities to manage rescue operations. The main victims at night-time are in multi-apartment buildings, and in the day-time in multi-apartment buildings, in educational institutions, hospitals, department stores, factories, etc) [1,5]. On the base of statistical data of the 1988 Spitak earthquake to assess the number of victims in one destroyed apartment, it is necessary to 2.0-2.5 people in one destroyed flat in the day-time. At night, the number of victims will be even greater, about 3 people. According to the same statistics, with 10 victims, there will be 15 injured to be hospitalized.

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