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EVOLUTION OF THE REGULATIONS REGARDING THE ANTI-SEISMIC PROTECTION OF BUILDINGS FROM THE TOWN OF SUCEAVA

BY

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Abstract. Through the modifications brought to the outlines of the macroseismic zoning maps and the intensity of the seismic hazard, of the factor of the structure behaviour, of the factor of dynamic amplification, etc, the value of the seismic forces of projection of buildings achieved within the period 1940-2013, in different localities, was variable in time and, consequently, their initial level of seismic security is uneven and, usually, inferior to the requirements of the present regulations, Code P100-1/2013.

As a result of the evolution of the technical regulations, the town of Suceava passed through a period in which it was not covered by the anti-seismic norms, period in which all central area of the town of Suceava was built.

Keywords: seismic hazard; time; evolution; Suceava town.

1. Introduction

The Romanian codes assigned to the projection of buildings located in seismic areas suffered a continuous evolution in the last 70 years. The first

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regulation dates back in December 1941, after the earthquake in Vrancea from November 10, 1940 and had as basis an Italian norm from 1938. This regulation provided taking into consideration a basic seismic force equal to 5% from the resultant of the gravitational forces, evenly distributed on the floor of the building.

Since that period until now, the projection instructions have been entirely modified, being improved due to the new data collected after each severe earthquake and the scientific progress, at present being named "seismic projection codes".

Further we will describe the content of the regulations of seismic projection that were on the basis of seismic projection of buildings in Romania.

2. The Evolution of Technical Regulations of Seismic Projection

2.2. Provisional Instructions to Prevent the Deterioration of Buildings Because of Earthquakes and for the Renovation of the Degraded Ones

The first regulation dates back in December 30, 1941 "*Provisional instructions to prevent the deterioration of buildings because of earthquakes and for the renovation of the degraded ones"*, after the earthquake in Vrancea from November 10, 1940, and had as basis an Italian norm from 1938. This regulation provided taking into consideration a basic seismic force equal to 5% from the resultant of the gravitational forces, evenly distributed on the floor of the building.

On the basis of this regulation the buildings were calculated taking into consideration only the gravitational loadings.

2.2. STAS 2923-58 General Prescriptions of Projection in Seismic Regions. Seismic Loadings

This regulation was drawn up by IPC, eng. Em.Ţiţaru and IPROBUC, prof. Al.Cişmegiu, but was not approved.

2.3. STAS 2923-52 Macroseismic Zoning Map

The first territorial macroseismic zoning map was regulated by STAS 2923–1952 (Fig. 1) and divided the territory into non seismic areas and seismic areas with different degrees of intensity.

According to this map, Suceava county is divided into two from the seismicity point of view, the West part being in the non seismic area and the East part being in the area with the seismicity degree 6.

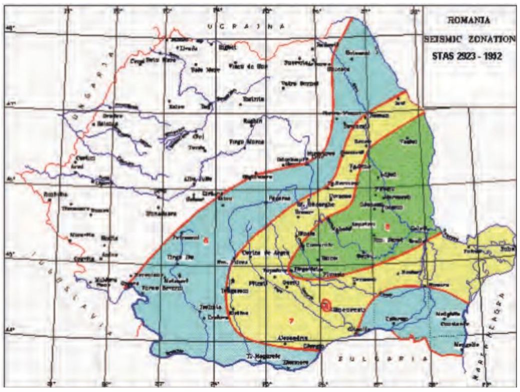

Fig. 1 − Macroseismic zoning map STAS 2923 – 1952

2.4. Conditioned Norm for the Projection of Civil and Industrial Constructions from Seismic Regions P 13-63, with Macroseismic Zoning Map STAS 2923-63

The projection norm P13-63 came into force on July 18, 1963, being drawn up consistent with "*The basic rules for the protection of buildings in seismic regions*" and was inspired by the Soviet Norm SN8-1957. The adaptation of these rules to the seismic conditions specific to the Romanian territory was done considering the destructive effects of the earthquake in Vrancea from 1940, the ascertainments from the strong earthquakes from other countries situated in the high-seismicity areas and recommendations from the international specialty conferences. Then there were no registrations of some seismic movements in locations on the Romanian territory.

The seismic projection norm P13-63, associated with macroseismic map from STAS 2923-63 (Fig. 2) replaced the similar map from STAS 2923-52, and introduced important reductions of the projection seismic intensity in many areas , including the town of Suceava.

According to P13-63, it was not requested the conformance and dimensioning of the structures and non structural components under the effect of seismic forces, irrespective of the material they are made of, of the buildings in the area of seismic degree 6 MSK.

The horizontal seismic force according to P13-63 was calculated as follows:

$$S = c \cdot Q \tag{1}$$

$$c = k_S \cdot \beta \cdot \varepsilon \cdot \psi \tag{2}$$

where: S is the horizontal seismic force; $c \geq 0{,}02$; k_S – the influence of the seismicity rate calculation; β – dynamic coefficient; ε – equivalence coefficient; ψ – coefficient which takes into consideration the influence of the material and the structure of the construction on the absorbtion of vibrations through internal friction produced by the seismic loadings.

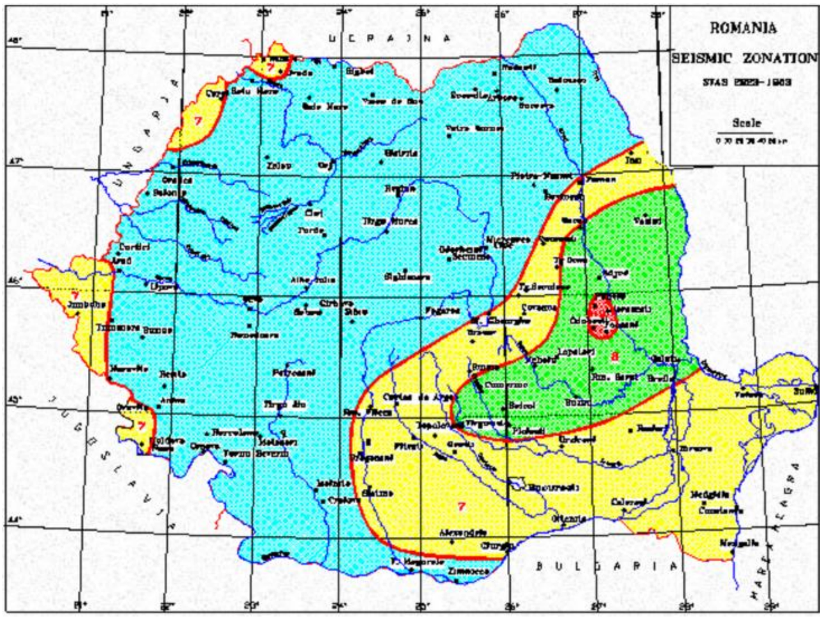

Fig. 2 – Macroseismic zoning map STAS 2923 – 1952.

The values of dynamic coefficient β were calculated depending on the category of the land according to Table 1.

Table 1

The Calculation Formulae of Coefficient β, According to Norm P13 – 63

The allowable pressure to fundamental loadings	β
$\sigma \geq 2\,kg/cm^2$	$0{,}6 \leq \beta = \dfrac{0{,}9}{T} \leq 3$
$\sigma < 2\,kg/cm^2$	$0{,}6 \leq \beta = \left(\dfrac{0{,}9}{T}\right) \cdot 1{,}25 \leq 3$
Muddy wetlands, soft lands soaked with water to the base level	$0{,}6 \leq \beta = \left(\dfrac{0{,}9}{T}\right) \cdot 1{,}50 \leq 3$

The values of the coefficient ψ were set as follows:

Table 2
The Values of the Coefficient ψ, According to Norm P13- 63

Type of construction	ψ
a) For all constructions, except those mentioned at b) and c) below;	1
b) For all constructions with skeleton in reinforced- concrete frames and constructions with roof articulated on reinforced- concrete pillars;	1.2
c) For high, very flexible construction, like independent flues, water tower, radio or television aerials, towers, etc.	1.5

The seismicity rate calculation for constructions was set according to P13-63 depending on the category of importance of the construction and the macroseismic zoning map (Fig. 2), of which the seismicity rate calculation resulted. The coefficient k_S which considered the seismic intensity was determined according to table 3 depending on the seismicity rate calculation.

Table 3
The Values of Coefficient k_S According to Norm P13-63

Seismicity rate calculation of construction	k_s
7	0.025
8	0.05
9	0.10

The provisions of norm P13-63 led to the situation that the whole built environment achieved between 1963,...,1977 and classified in the areas of degree 6 MSK according to macroseismic zoning map was not calculated at the action of seismic forces, and at the projection of buildings were not compulsory at least the minimal constructive measures. Within this period were built, especially in big towns (including Suceava), county capitals and important municipal towns, residential buildings and hotels, reaching up to 8 ÷ 10 levels, hospitals, schools, gyms, auditoriums, etc.

2.5. Seismic Projecion Norm P13-70, with Seismic Zoning Map STAS 2923-63

On December 31, 1970 it was approved the revised edition of P13-63 norm, with the name “Norm for the projection of civil and industrial constructions from seismic regions”, P13-70. The new norm wanted to be an improved version of the previous norm, having at the basis the modifications from the foreign norms and speciality research made within the country and abroad. These modifications led to the reduction of conventional seismic force by approximately 20% at the structures in reinforced- concete frames.

For the first time it was made the observation that both the norm P13-63 and the foreign norms, were not assessing directly the behaviour of the structures in plastic range during the strong earthquakes. The rapid and repeated forays in the plastic range, in case of some structures with post-elastic deformation capacities, make possible the dissipation of a considerable part from the energy induced in the structure by a severe earthquake.

The norm P13-70 introduces for the buildings from the class of importance I and the seismic degree 6 MSK the requirement of seismic calculation.

The horizontal seismic force according to P13-70 was calculated as follows:

$$S = c_r \cdot Q \tag{3}$$

$$c_\gamma = k_S \cdot \beta_r \cdot \varepsilon_r \cdot \psi \tag{4}$$

where: S is the horizontal seismic force; k_S – coefficient which introduces the influence of seismicity of the location and the functional importance of the construction; β_r – coefficient which introduces the influence of the proper period T_r and the foundation soil; ε – equivalence coefficient between the system with more degrees of freedom and the system with a degree of freedom corresponding to the proper mode (r); ψ – coefficient which considers the influence of the material and the structure of the construction on the absorption of the vibrations through internal friction produced by the seismic loadings.

Values of the coefficient β_r were calculated depending on the land category, according to Table 4.

Table 4

Formulae of Calculation of Coefficient β_r, According to Norm P13-70

Land category	β
Normal foundation soils;	$\beta_r = \frac{0,8}{T_r}$ $0.6 \le \beta_r \le 2$
Rocky foundation soils, consolidated ballastings strata, dusty, sandy clays, etc of reduced consistency, sands in mellow state, high moisture loess, or in case of lands with high underground water level; *Note: The values of the coefficient βr are reduced by 20%, except masonry or prefabrication reinforced concrete buildings.*	$\beta_r = \frac{0,8}{T_r}$ $0.6 \le \beta_r \le 2$
Foundation soils made of clay ground, dusty clays, etc of reduced consistency, sands in mellow state.	$\beta_r = \frac{0,8}{T_r} \cdot 1.5$ $0.6 \le \beta_r \le 2.5$

Values of coefficient ψ were set according to Table 5.

Table 5
Values of Coefficient ψ, According to Norm P13-70

Type of construction	ψ
Frame structure constructions;	1.0
Membrane structure constructions;	1.2
Load- bearing masonry constructions;	1.3
High, very flexible, independent construction, like flues, radio and television aerials, etc.	1.8
Water towers.	0.8

The provisions of norm P13-70 led to a slight improvement because for the buildings from exposure class I and degree 6 MKS the seismic action was considered.

2.6. Anti-Seismic Projection Norm P100-78 (81), with Seismic Zoning Map STAS 11100/1-77

The effects of the earthquake from March 4, 1977, the conclusions obtained after the “in situ” observations, and the registration of the acceleration of the land from the seismic station INCERC- Bucharest during this major earthquake in Vrancea determined the successive elaboration of two new regulations: “Norm for the anti-seismic projection of social- cultural, agricultural-zootechnical and industrial residence buildings”, P100- 78 (with experimental application) and the improved version of Norm P100-81.

The Regulations of seismic projection introduced in 1978 substantially modified the previous regulations, first, it was modified the seismic zoning of the territory, the macrozoning map STAS 2923-63 being replaced by the map from STAS 11100/1-77 (Fig. 3) in order to consider the effects found on the occasion of the earthquake from 1977.

After the 1977 earthquake the first accelerogram registered on the territory of Romania was obtained (INCERC), at a severe earthquake, which was used then, as a reference point for the territory zoning from the horizontal acceleration point of view and for the settlement of the elastic response spectrum.

Therewith, P100-78(81) introduced the compulsoriness of seismic projection for the buildings located in the areas of degree 6 MSK (except some reduced- risk building categories) and reduced the number of classes of importance from 5 in the previous norm, to 3.

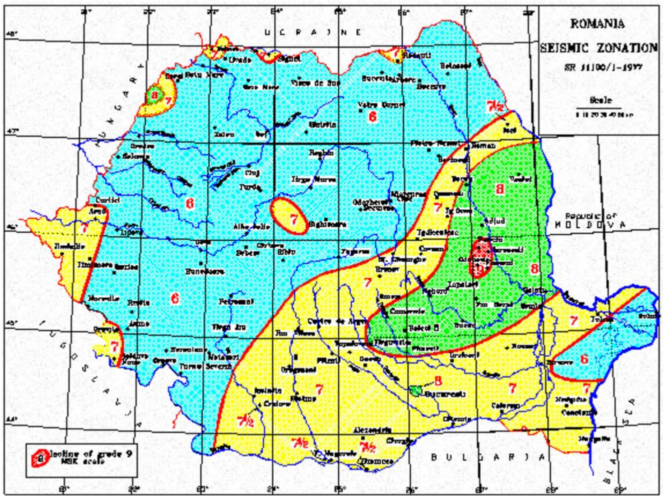

Fig. 3 − Macroseismic zoning map STAS 11100/1-77.

The conversion of the anti-seismic protection degree in coefficient k_s was made according to Table 6.

Table 6

Conversion of the Anti-Seismic Protection Degree in Seismic Coefficients

The anti-seismic protection degree of building	6	6.5	7	7.5	8	8.5	9
K_S	0.07	0.09	0.12	0.16	0.20	0.26	0.32

The horizontal seismic force according to P100-78 (81) was calculated as follows:

$$S_r = c \cdot G \tag{5}$$

$$c = k_S \cdot \beta_r \cdot \varepsilon_r \cdot \psi \tag{6}$$

where: S is the horizontal seismic force; k_S – coefficient corresponding to the anti-seismic protection degree of the building; β_r – dynamic coefficient corresponding to the proper mode of vibration r of the building; ψ – coefficient of reduction of the effects of seismic loadings, considering the ductility of structure, the capacity of redistribution of efforts, the weighting with which the resistance reserves not considered in calculation intervene, resulted in calculation from the work of structure with non structural elements and the effect of the absorption of vibrations; ε_r – the equivalence coefficient between the real system and that with a degree of freedom, corresponding to the proper mode of vibration r; G – the resultant of gravitational loadings.

Table 7
Calculation Formulae of Coeffcient β_r, According to Norm P100-78

The allowable pressure to fundamental loadings	β
Foundation soils of normal rigidity.	$\beta_r = \frac{3}{T_r}$ $0.75 \le \beta_r \le 2$
Rigid foundation soils: rocky lands, strata made of stable sand deposits, gravel or big consistence clays (tertiary or older strata) etc, the values of coefficient βr are reduced by 20%, respecting the condition.	$\beta_r = \frac{0.8}{T_r}$ $0.75 \le \beta_r \le 2$
Foundation soils with reduced rigidity: strata made of reduced consistency clays with or without sand or other non cohesive formation interlayers, sands in mellow state, loess with high humidity or in case of clay or sandy lands with a high level of underground waters, the values of the coefficient increase by 30%.	$\beta_r = \frac{0,8}{T_r} \cdot 1.5$ $0.75 \le \beta_r \le 2.5$

Values of coefficient ψ was set according to Table 8.

Table 8
Values of Coefficient ψ, According to Norm P100- 78

Type of construction and constructive system	ψ
Rigid structure buildings (load- bearing walls of masonry or reinforced- concrete, monolith or prefabricated membranes) or semi- rigid (membranes with frames):	
• To the ground floor + 4 floors (≤ 5 levels) and with total height to 15 m;	0.30
• Above the ground floor + 4 floors (> 5 levels) or with total height over 15 m;	0.25
Buildings storied in frames:	
• With one span;	0.25
• With more spans;	0.20
Industrial halls with one level and other buildings type hall:	
• With one span;	0.20
• With more spans;	0.15
Silos and other special constructions with rigid structure;	0.25
High, very flexible constructions, like flues, independent towers, etc.	0.35
Water towers.	0.35

Considering the big damages registered in 1977, the hazard level was increased by ½ MSK degree, locally, for the towns of Craiova, Iaşi, Zimnicea nd Turnu Măgurele and the municipal town of Bucharest became an island with 8 MSK intensity in the 7 MSK intensity zone of Muntenia.

Beginning with the introduction of these technical regulations the buildings in the town of Suceava were calculated considering the seismic action with degree 6 MSK (except some categories of reduced -risk buildings).

2.7. Anti-Seismic Projection Norm P100- 91(92), with Proper Zoning Maps

After approximately 10 years, on the basis of speciality researches made in the country and in the world, and the movements registered in the national seismic networks at the strong earthquakes in Vrancea from August 30, 1986 and May 30, 31, 1990, appeared Norms P100-91 and P100- 92. These norms of seismic projection were drawn up in a modern manner, the effects associated to the position of the location and the land conditions being included in the macrozoning seismic map and in the zoning map depending on the corner periods Tc. In comparison with norm P100- 81, in which 7 areas with different degrees of seismic protection are mentioned, in the last norms are considered only 6 seismic areas of calculation from A to F (Fig. 4).

Therewith, P100- 91(92) increased the number of classes of importance from 3 in the previous norm , to 4 classes of importance.

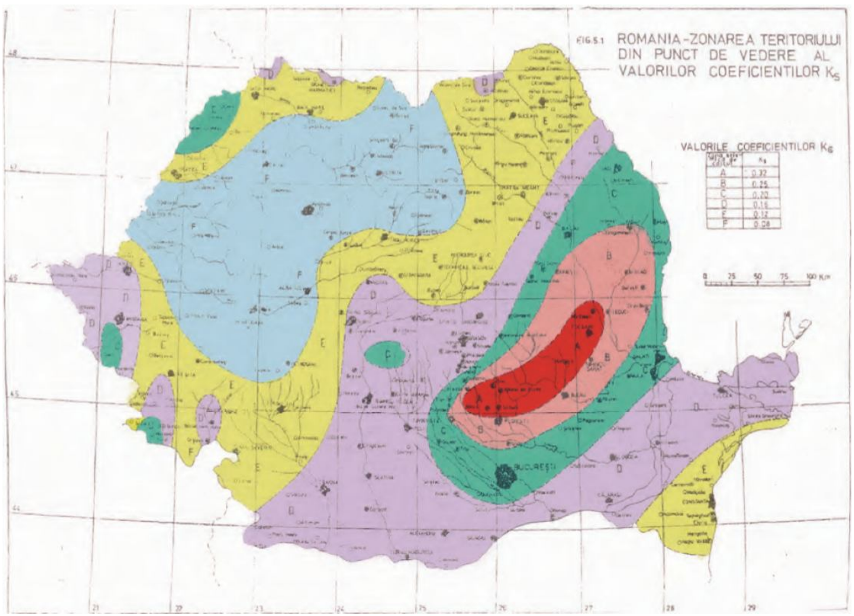

Fig. 4 − Macroseismic zoning map according to P100- 91 (92).

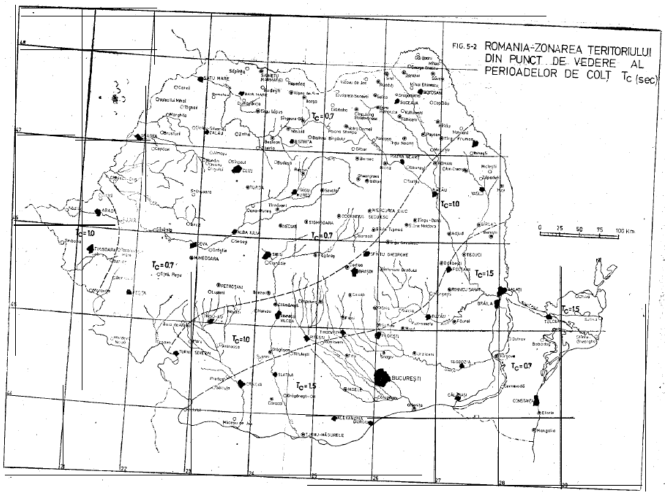

Fig. 5 − Zoning map of the territory in terms of control (corner) period Tc according to P100-91 (92) of macroseismic zoning according to P100-91(92).

Horizontal seismic force according to P100- 90 (92) was calculated as follows:

$$S_r = c_r \cdot G \tag{7}$$

$$c_r = \alpha \cdot k_s \cdot \beta_r \cdot \varepsilon_r \cdot \psi \tag{8}$$

where: S_r is the horizontal seismic force; α – coefficient of importance of building, depending on the class of importance; k_S – coefficient depending on the seismic area of calculation of the location; β_r – coefficient of dynamic amplification of the mode *r* of vibration, depending on the spectral composition of the seismic movement of location; ψ – coefficient of reduction of the effects of the seismic action considering the ductility of the structure, the capacity of redistribution of efforts, the weighting with which the resistance reserves not considered in calculation intervene, and the effects of absorption of vibrations, other than those associated to the resistance structure; ε_r – the equivalence coefficient between the real system and that with a degree of freedom, corresponding to the proper mode of vibration *r*; *G* – resultant of the gravitational loadings.

Values of the dynamic coefficient βr were calculated as follows:

$$\beta_r = 2.5 \quad \text{for} \quad T_r \le T_C \tag{9}$$

$$\beta_r = 2.5 - (T_r - T_C) \ge 1 \quad \text{for} \quad T_r > T_C \tag{10}$$

Values of the coefficient ψ were set according to Table 9.

Table 9

Values of Coefficient ψ, According to P100- 91(92)

Type of construction and constructive system	ψ
REINFORCED- CONCRETE STRUCTURES	
Structures in storied frames	
• Backing walls are treated as structural elements ensuring working with the frame elements;	0.25
• Backing walls are not treated as structural elements.	0.20
Industrial halls and other one -level structures:	
• With rigid connections between collar beams and pillars;	0.15
• With articulated connections.	0.20
Structures with structural walls;	0.25
Structures with walls, pillars and slab floors (without beams);	0.30
High constructions, flue type; * According to specific norms	–
Water towers;	0.35
Silos.	0.25
MASONRY STRUCTURES	
Structures with strucrtural walls of masonry with belts and little pillars;	0.25
Structures with structural walls of simple masonry.	0.30
METALLIC STRUCTURES	
Industrial halls and other one -level structures	
• In vertical non braced direction	
• with one span;	0.20
• with more spans.	0.17
• In vertical non braced direction	
portal with cross studs held centrically at knots:	
• with “V” cross studs	0.40
• with broad cross studs.	0.20
portal with cross studs eccentrically held at knots:	0.20
Structures in storied frames	0.17
Structures made of rigid vertical elements with bars centred at knots	
• with broad cross studs;	0.25
• with “V” cross studs, which work at compression.	0.50

According to this norm of anti-seismic projection of buildings, the town of Suceava was in the seismic area of calculation E with k_s = 0,12 to which it corresponds according to the old norms degree 7 MSK .

2.8. Seismic Projection Code P100-1/2004 (2006), with Proper Zoning Maps

The seismic projection code “Provisions of projection for buildings- Part I”, indicator P100-1/2004, is registered in the series of revisions at a consacrated interval of approximately 10 years. This code was subsequently modified after the experimental application and after a correlation with the provisions of Eurocodes, resulting the code P100-1/2006. This code is drawn up on the skeleton and in the format of the European code E38 (SR EN 19981:2004), having as main purpose harmonizing the regulations from our country with the ones from the European Union. In this code is included the current international knowledge with applicability to the seismic conditions specific to the Romanian territory. The significant differences compared to the norm P100- 92 refer to the representation of the seismic action, to the performance requirements, to detailing the provisions specific to reinforced-concrete, metal, masonry, wood and steel- concrete composite constructions, to the non structural components, to the control of the structural response by isolating the base and last but not least, to the notations and calculation relations.

In the code P100- 1/2006, the zoning of Romania for the projection of constructions at the seismic action was done on the basis of two criteria, as follows:

- The seismic intensity is defined according to the acceleration of the projection land, noted with a_g, and which divides the territory into seven areas (a_g = 0.08 g ÷ 0.32 g) according to Fig. 6;
- The control (corner) period of the elastic response spectrum in accelerations noted Tc and the division of the territory into three areas (TC = 0.7 sec, TC = 1 sec and TC = 1.6 sec) according to Fig. 7.

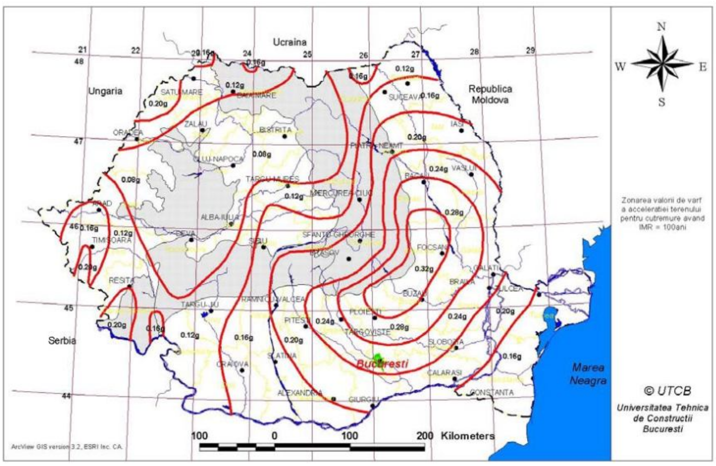

Fig. 6 − The zoning of the Romanian territory in terms of top values of the acceleration of the projection land a_g for earthquakes having the average recurrence interval IMR=100 years according to P100- 1/2006.

Fig. 7 – The zoning of the Romanian territory in terms of control (corner) period, T_C of the response spectrum.

As a novelty, the code P100-1/2006 introduced two levels of severity for the two projection requirements:

- The acceleration of the projection land for each area of seismic hazard corresponds to an average recurrence interval IMR = 100 years, with the mention that the interval refers to magnitudes and without considering the type of predominant earthquake (intermediary/ crustal).
- An earthquake with IMR = 30 years is mentioned in relation with the requirement of limitation of degradations.

Therewith, P100-2006 kept the number of classes of importance of buildings as in the previous norm, but modified the symbol of the coefficient of increasing the seismic hypothesis and the description of the classification of constructions in classes of importance.

The basic cutting force corresponding to the proper fundamental mode according to P100-1/2006 is calculated as follows:

$$F_b = \gamma_I \cdot S_d\left(T_1\right) \cdot m \cdot \lambda \tag{11}$$

where: γ_I is the factor of importance – exposure of construction; $S_d(T_1)$ – ordinate of the projection response spectrum corresponding to the fundamental period T_1, expressed in m/s^2;

$$0 < T \le T_B \rightarrow S_d\left(T\right) = a_g \cdot \left[1 + \frac{\frac{\beta_0}{q} - 1}{T_B} \cdot T\right] \tag{12}$$

$$T > T_B \rightarrow S_d(T) = a_g \cdot \frac{\beta(T)}{q} \tag{13}$$

m – total mass of the building calculated as a sum of masses of level m_i; λ – correction factor which takes into account the contribution of the proper fundamental mode through the effective modal mass associated to it; λ = 0.85 if $T_1 \leq T_C$ and the building has more than two levels; λ = 1 in other situations; *q* – factor of behaviour of structure, determined depending on the type of the structure according to Tables 10 and 11 from " Seismic projection code P100-1/2006"; β_0 – maximum dynamic amplification factor of the horizontal acceleration of the land by the structure; $\beta(T)$ – normalized elastic response spectrum;

$$0 \leq T \leq T_B \rightarrow \beta(T) = 1 + \frac{\beta_0 - 1}{T_B} \cdot T\,, \tag{14}$$

$$\mathrm{T_B} < \mathrm{T} \leq \mathrm{T_C} \rightarrow \beta(T) = \beta_0\,, \tag{15}$$

$$\mathrm{T}_C < \mathrm{T} \leq \mathrm{T_D} \rightarrow \beta(T) = \beta_0 \cdot \frac{T_C}{T}\,, \tag{16}$$

$$\mathrm{T} > T_D \rightarrow \beta(T) = \beta_0 \cdot \frac{T_C \cdot T_D}{T^2}\,. \tag{17}$$

Table 10

Control (Corner) Periods P100-2006

Average recurrence interval of the earthquake magnitude	*Values of the control periods*			
IMR = 100 years	T_B	0.07	0.10	0.16
	T_C	0.7	1.0	1.6
For the last limit state	T_D	3	3	2

Modification of the seismic coefficient k_S in the acceleration of the projection land a_g was done according to Table 11.

Table 11

Conversion of the Seismic Coefficient k_s in the Acceleration of the Projection Land a_g

Seismic area calculation (a_g), [g]	0.32	0.28	0.24	0.20	0.16	0.12	0.08
$k_S = \frac{a_g}{g}$	0.32	0.28	0.24	0.20	0.16	0.12	0.08

According to this seismic projection code, the town of Suceava is classified in the area with a_g = 0.16 g, seismic intensity superior to the previous code.

2.9. Seismic Projection Code P100- 1/2013, with Proper Zoning Maps

The present seismic projection code, P100- 1/2013 provides the same parametres for the hazard description as in P100- 1/2006, but the followig essential modifications were done:

- For the earthquake of projection in last limit state (ULS), the IMR value was increased from IMR= 100 years to IMR= 225 years (probability of surpassing the acceleration value 20% in 50 years);
- The seismic action for the requirement of degradation limitation (SLS) corresponds to an average recurrence interval IMR= 40 years (probability of surpassing of 20% in 10 years);
- The value of the top acceleration of the projection land at ULS was increased by 25% evenly, on the whole territory of the country, independent of the seismogenic dominant source keeping the outlines of equal acceleration from P100- 1/2006;
- The outlines and the values of areas Tc are identical with those from P100-1/2006.

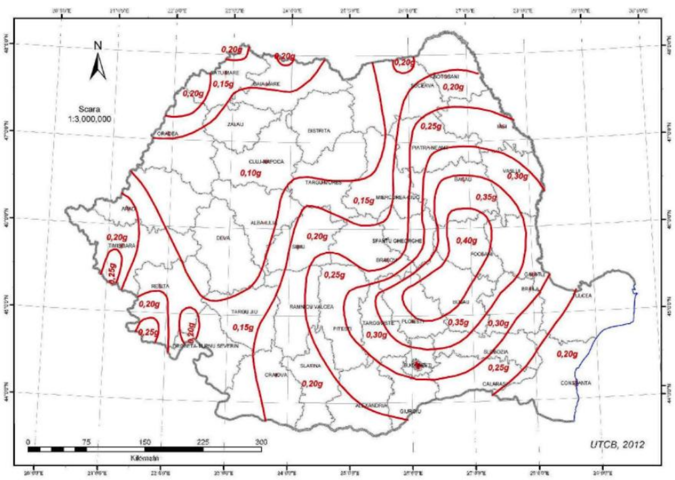

Fig. 8 − Zoning of the Romanian territory in terms of top values of the acceleration of projection land a_g for earthquakes having the average recurrence interval IMR = 225 years according to P100-1/2013.

According to this seismic projection code the territory is divided into seven areas, the town of Suceava being in the area with a_g = 0.20g, the seismic intensity being increased by 25% in comparison with the previous projection code.

3. The Synthesis of the Evolution of Seismic Hazard at the Level of the Town of Suceava

As a result of the evolution of the technical regulations the town of Suceava passed through a period in which it was not covered by the anti-seismic norms, period in which all the central area of the town of Suceava was built. A graphic representation of the evolution is presented in Fig. 9.

Table 12
Evolution of Seismic Hazard at the Level of the Town of Suceava

Norm/Code	Hazard level	Seismic calculation
P13-63	Seismic degree 6 MSK ≈ Ks =0.07 ≈ a_g = 0.07 g	NO
P13-70	Seismic degree 6 MSK ≈ Ks =0.07 ≈ a_g = 0.07 g	NO
P100-78(81)	Seismic degree 6 MSK ≈ Ks =0.07 ≈ a_g = 0.07 g	YES
P100-1/91(92)	Seismic degree 7 MSK ≈ Ks =0.12 ≈ a_g = 0.12 g	YES
P100-1/2006	Seismic degree 7.5 MSK ≈ Ks =0.16 ≈ 0.16 g	YES
P100-1/2013	Seismic degree 8 MSK ≈ Ks =0.20 ≈ 0.20 g	YES

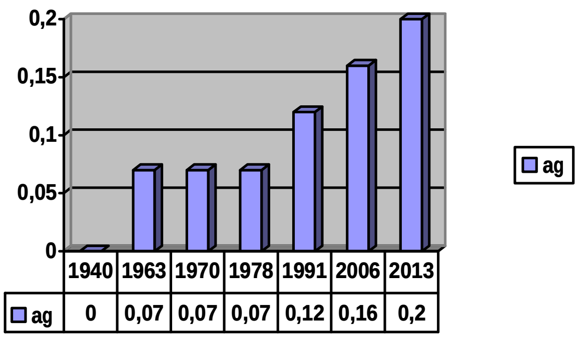

Fig. 9 – Evolution of seismic hazard at the level of the town of Suceava.

4. Conclusions

Through the modifications brought to the outlines of the macroseismic zoning maps and the intensity of the seismic hazard, of the factor of structure behaviour, of the factor of dynamic amplification, etc., the value of seismic forces of projection of buildings achieved within the period 1940-2013, in different localities, was variable in time, and, consequently, the initial level of seismic security of these is uneven and, usually, inferior to the requirements of the present regulations, to the Code P100-1/2013.

An urgent seismic evaluation of the buildings built within the period 1940-1978 in the town of Suceava is necessary, because these buildings accommodate a very big number of persons and at their projection it was not required the conformance and dimensioning of the structures and non structural components under the effect of seismic forces.

For the future is taken into account the passing from an average recurrence interval of reference of 475 years, according to the approaches from Eurocode 8, which will imply increased requirements in comparison with the present requirements from the seismic projection code P100-1/2013, being necessary a new modification of the zoning map of the acceleration of projection land a_g and implicitly its value, which will lead to the increase of vulnerability to the seismic action of the existing buildings.

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EVOLUŢIA REGLEMENTĂRILOR PRIVIND PROTECŢIA ANTISEISMICĂ A CONSTRUCŢIILOR DIN ORAŞUL SUCEAVA

(Rezumat)

Prin modificările aduse contururilor hărtilor de zonare macroseismică şi a intensitaţii hazardului seismic, a factorului de comportare al structurii, al factorului de

amplificare dinamică etc., valoarea forțelor seismice de proiectare a clădirilor realizate în perioada 1940-2013, în diferite localități, a fost variabilă în timp şi, prin urmare, nivelul de siguranță seismică inițial al acestora este neuniform şi, de regulă, inferior cerințelelor reglementărilor actuale, Codului P100-1/2013.

Ca urmare a evoluție reglementărilor tehnice oraşul Suceava a trecut printr-o perioadă în care nu a fost acoperit de normativele antiseismice, perioadă în care s-a construit toată zonă centrală a oraşului Suceava.