CHAPTER 1. GENERALITIES

1.1. INTRODUCTION

The present Norm establishes the requirements and minimal provisions for the design, construction, repair and construction's reinforcement that they could be submitted to seismic excitement.

The seismic design loads, analysis procedures, resistance and stability requirements, deformation limitations, constructive arrangements and general provisions are established with the following objective:

-Avoid losses of human lives and accidents that they could be originated by the occurrence of any seismic event, protecting the services and goods of the population..

-Avoid damages in the structure and in the components of the construction during the frequent occurrence of earthquakes.

-Reduce to the minimal the damages in the non structural components and avoid prejudices in the structure during earthquakes of median intensity.

-Avoid collapses and damages in the construction that they could put in danger to the persons or that cancel totally the structures during very severe earthquakes of extraordinary occurrence.

-Achieve that the essential constructions intended for the emergency services continue operating, even after destructive earthquakes.

1.2. SCOPE

These Regulations are applied to all the new constructions that are accomplished within territory of the Republic of Argentina, to the reinforcement of the existing constructions executed without earthquake resistant provisions and to the repair of the constructions that resulted damaged by the action of the earthquakes.

For those works of extraordinary importance or magnitude, that by their characteristic require studies and special tests, as for example: essential areas of central nuclear, large dams and hydraulic works, bridges and tunnels with lights superior to 150 m, etc., will be adopted the present Norms as fundamental limit in those aspects in which could be applicable.

CHAPTER 3. SEISMIC ZONING

3.1. The territory of the Republic Argentina is divided into five zones according to the degree of hazard seismic. These zones are indicated in the map of the Figure 1 and with more detail in the map with scale 1:5 000 000 that it publishes by the National Institute of Seismic Prevention (INPRES).

In Table 1 is specified the seismic zoning of the national territory in function of the degree of hazard seismic.

Table 1. Zoning of the Republic Argentina in function of the degree of hazard seismic

seismic zone	Level of seismic hazard
0	Very low
1	Low
2	Moderate
3	High
4	Very high

If the place of site of the construction coincides with the line that delimits two zones, or if there are doubts about its location with respect to the border, then it should be considered located in the zone of greater degree of hazard seismic.

3.2. The different seismic zones are integrated by the provinces, departments or part of departments that are indicated below:

CHAPTER 4. APPLICATION OF SEISMIC RESISTANT REQUIREMENTS

4.1 In the zones 1, 2, 3 and 4 it will be applied completely 105 requirements that was established by the present Regulation for the project and construction of earthquake resistant structure.

4.2. In the zone 0, the requirements are established according to the types of construction:

4.2 1. For constructions whose defect would produce catastrophic effects on vast sectors of population (for example: deposits of gases or toxic liquids,

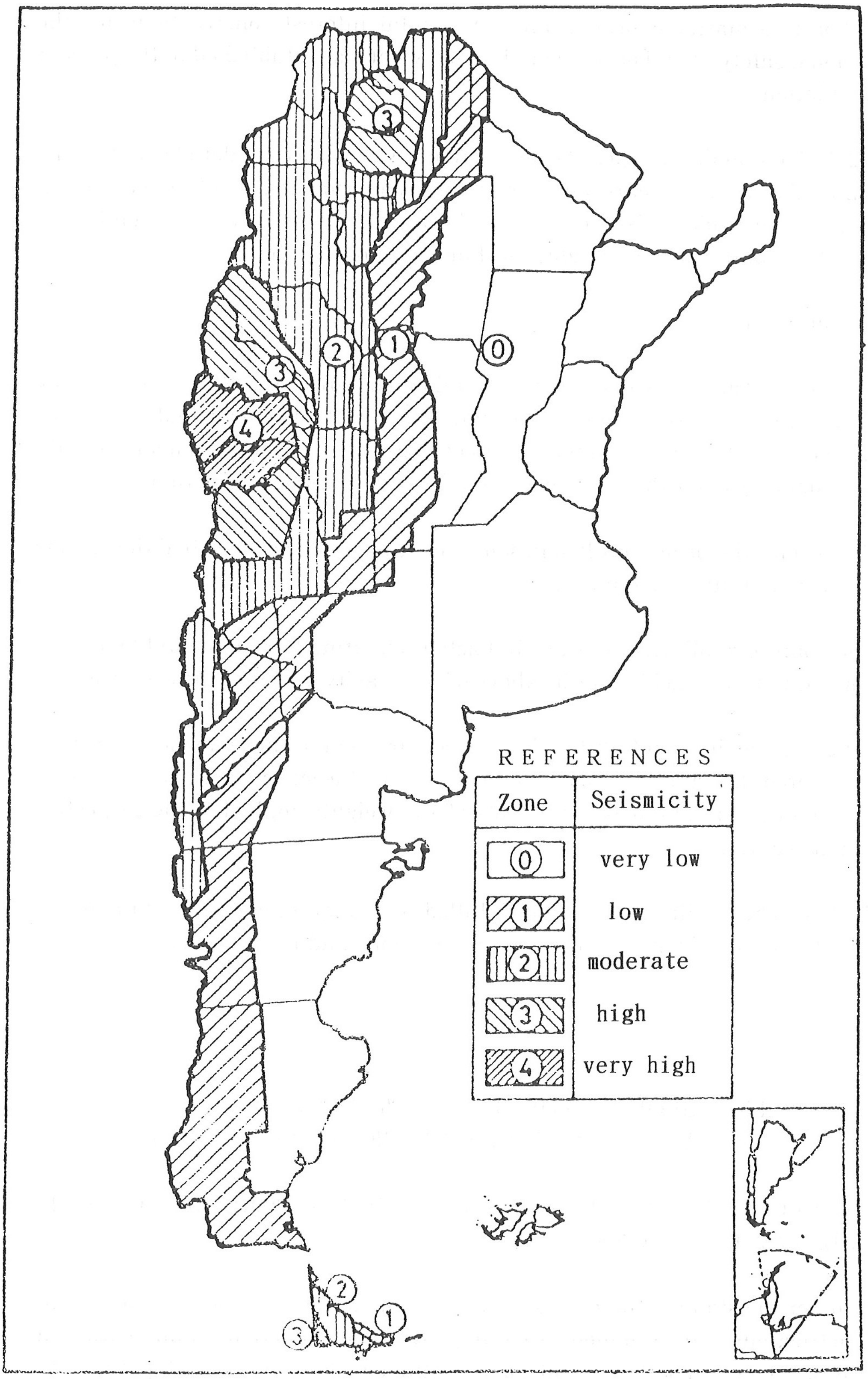

Figure 1 Seismic Zonation of the Argentine Republic

radioactive matter deposits, and so) or vital interest constructions for the national safety, it will be of all application what was established in the present Regulation.

4.2.2. The remaining types of constructions, which are considered satisfied the minimal provision of earthquake resistant requirements, should have vertical planes to provide resistance against horizontal forces in two perpendicular directions and to assure an able mechanism to resist twists.

Furthermore:

4.2.2.1. For the constructions whose total height surpasses 12 w and that they may have been verified under the wind effects in the two principal directions, will be controlled that the resulting in each direction of the wind load it should be equal or greater that 1.5% of the total weight of the construction.

If this condition is not fulfilled in some direction, must be amplified the actions of the wind until satisfying it.

The point of application of the wind action resulting force it should be to find approximately coincident or by above of the gravity center of the construction.

4.2.2.2. When it is not fulfilled this last requirement or they may not have been considered the wind effects, it should be verified the structure under the action of equal horizontal forces to the 1.5% of 105 weights applied in the respective gravity centers.

4.2.2.3. They will have to be fulfilled the requirements on bracing of foundations established in the Chapter 17. Soils and Foundations.

CHAPTER 5. GROUPING OF THE CONSTRUCTIONS ACCORDING TO THEIR USES AND FUNCTIONS

5.1. GROUPING OF THE CONSTRUCTIONS ACCORDING TO THEIR USES AND FUNCTIONS

In order to establish the provision of earthquake resistant requirements, the constructions are grouped according to their functions and with the transcendence that they could have contingent damages or collapses of the same in the event of earthquake's occurrence.

5.1.1. Group Ao

Constructions or facilities that present some of the following characteristics: .

a) fulfill essential functions in the event of destructive earthquakes occurrence;

b) their fault could produce catastrophic effects on vast sectors of population.

These constructions and their corresponding facilities should follow operating after destructive earthquakes, therefore their accesses should be specially designed.

5.1.2 Group A

Constructions or facilities that present some of the characteristic following:

a) their defect serious cause consequences, causing indirect or direct losses exceptionally expensive related with the cost that implies the increase of their safety (great occupation density, content of great value, important functions for the community).

b) result from interest for the production and national safety.

5.1.3. Group B

Constructions and facilities whose collapse would produce losses of intermediate magnitude (normal occupation density, content of normal value).

5.1.4. Group C

Constructions or facilities whose failures would produce lost of very low magnitude and it would not cause damages to constructions of the previous groups (provisional or isolated constructions not intended for room).

5.1.5. The constructions that by their nature could correspond to multiple functions, they will be classified in the group of the higher risk factor.

5.2. RISK FACTOR

5.2.1. For the determination of the seismic actions and monitorings indicated in this Regulation, in Table 2 is establish the securities of the risk factor gd according to the group to which it will be assigned the construction (to see the article 5.1.).

5.2.2. For the constructions that belong to the group C is not required to accomplish the analysis under the seismic actions. However, in their conception and execution should be taken into account arrangements and details that contribute to provide them of protection earthquake-resistant.

Table 2. Value of the corresponding risk factor to each group of constructions.

Construction	Risk Factor γd
Group Ao	1.4
Group A	1.3
Group B	1.0

CHAPTER 6. LOCAL CONDITIONS OF THE SOIL

The local conditions of the soil profile where it is located the construction, have considerable influence on seismic response.

6. 1. CLASSIFICATION OF DYNAMICALLY STABLE SOILS

To take into account the influence in the spectral forms (see the article 7.2.), the dynamically stable soils (see the article 17.2.) are classified according to indicated it in Table 3.

6.1.1. When in the identification of the soil exist doubts with respect to the depth of the layer, to the mechanics characteristic of 108 different strata, etc., it will be adopted the coordinate of spectral values that result more unfavorable for the analyzed vibration periods.

Table 3. Classification of the foundation soils dynamically stable.

IDENTIFICATION			CHARACTERISTIC		
			shear wave velocity (m/s)	**Test of normalized penetration P.P.N. (blow-count)**	**admissible Tension of the soil σsadm, (MN/ m2)**
Type I	Very Hard Dense	a) Bed Rocks and similar formations	> 700	---	σsadm> 2
Type I	Very Hard Dense	b) Rigid Soils on rock firm, with depth of mantle less than 50 m (for example: gravel and very dense sands and compact; soils cohesive very hard with greater cohesion that 0.2 MN/ m2)	< 700 and > 400	> 30	.3<σsadm< 2
Type II	Intermidiate	a) rigid Soils with greater mantle depth that 50 m (For example: Gravel and very dense sand and compact; soils cohesive very hard with greater cohesion that 0.2 MN/m2)	< 700 and > 400	> 30	0.3<σsadm < 2
Type II	Intermidiate	b) Intermediate soil characteristics with mantle depth greater than 8 m (For example: Granular soils moderately dense; cohesive soils of soundness lasts with cohesive, cohesion among and 0.07 and 0.2 MN/ m2)	100 to 400	granular > 15 and <30 cohesion > 10 and < 15	0.1<σsadm< 13
Type III	Soft	Soils granular little dense; cohesive soils soft or medium stiff (Cohesion less than0.05 MN/ m2); soils collapsible	< 100	< 10	σsadm< 0.1

6.2. DYNAMICALLY UNSTABLE SOILS.

When it is determined that the foundation soils could result unstable (permanent deformations, liquefaction, temporary loss of the bearing capacity and so) under
108 levels of established seismic excitement tested (to see the Chapter 7), it should be taken into account expressed it in the Chapter 17. Soils and foundations.

CHAPTER 7. SEISMIC ACTIONS AND DESIGN SPECTRA

7.1. INTRODUCTION

The seismic excitement is defined basically through the equivalent acceleration spectra or spectra of pseudo accelerations.

The same express the equivalent accelerations as fractions of the acceleration of the gravity, in function of the dynamic characteristic of the structure.

The form and magnitude of the spectra depend on the seismic zone and of the type of foundation soil.

For the application of the modal combination method step by step, the seismic design excitement will be defined through accelerograms that fulfill the requirements specified in the article 14.3.1.

7.2 SPECTRA FOR HORIZONTAL SEISMIC ACTIONS

7.2.1. The coordinate S_a of the elastic design spectrum for horizontal actions, are determined through the following expressions:

$$S_a = a_s + (b - a_s).\frac{T}{T_1} \qquad \text{for} \qquad T \leq T_1$$

$$S_a = b \qquad \text{for} \qquad T_1 \leq T \leq T_2$$

$$S_a = b.(\frac{T_2}{T_1})^{\frac{2}{3}} \qquad \text{for} \qquad T \geq T_2$$

Where:

S_a the elastic pseudo acceleration expressed as fraction of the gravity acceleration;

a_s first coordinate value in the origin of the spectrum (maximum acceleration of the soil), expressed as fraction of the gravity acceleration;

b the coordinate of the soffit of the spectrum or maximum pseudo acceleration, expressed as fraction of the gravity acceleration;

T the generic vibration period, expressed in seconds;

T_1 the corresponding period to the beginning of the soffit, expressed in seconds;

T_2 the vibration period corresponding to the final of the soffit, expressed in seconds.

The a_s, b, T_1 and T_2 are function of the seismic zone and of the type of foundation soil.

In Table 4 are established the values of a_s, b, T_1 and T_2 for the different seismic zones and types of foundation soil.

7.2.2. The specified spectra consider a not inferior damping to the 5% of the critical. They will not be able to accomplish reductions for greater securities of damping, except in the showed circumstances in the article 12.3. The Figures 2 to 5 show the spectra of pseudo accelerations for each seismic zone.

7.2.3 For inferior damping to the 5% of the critical, the expressions that define the spectrum of pseudo accelerations will be the following:

$$S_a = a_s + (f_A.b - a_s).\frac{T}{T_1} \qquad \text{for} \qquad T \le T_1$$

$$S_a = f_A.b \qquad \text{for} \qquad T_1 \le T \le T_2$$

$$S_a = 1 + (f_A - 1)\frac{T_2}{T_1} \quad b(\frac{T_2}{T_1})^{\frac{2}{3}} \qquad \text{for} \qquad T \ge T_2$$

Where:

S_a the elastic pseudo-acceleration;

a_s coordinate in the origin of the spectrum;

b the coordinate of the soffit of the spectrum;
T the generic vibration period;

T_1 the corresponding vibration period to the beginning of the soffit;

T_2 the vibration period corresponding to the final of the soffit;

f_A the amplification factors by damping consider:

$$f_A = \sqrt{\frac{5}{\xi}} \quad \text{for } 0.5\% \leq \xi \leq 5\%$$

with x the considerate damping, expressed as percentage of the critical.

Table 4. Values of a_s, b, T_1 and T_2 for the different seismic zones and sorts of foundation soil.

SEISMIC ZONE	SOIL	a_s	b	T_1	T_2
4	Type I	0.35	1.05	0,20	0.35
	Type II	0.35	1.05	0.30	0.60
	Type III	0.35	1.05	0.40	1.00
3	Type I	0.25	0.75	0.20	0.35
	Type II	0.25	0.75	0.30	0,60
	Type III	0.25	0.75	0,40	1.00
2	Type I	0.16	0.48	0.20	0.50
	Type II	0.17	0,51	0.30	0.70
	Type III	0.18	0.54	0.40	1,10
1	Type I	0.08	0,24	0.20	0.60
	Type II	0.09	0,27	0,30	0,80
	Type III	0,10	0,30	0.40	1,20
0	Type I	0.04	0.12	0.10	1.20
	Type II	0,04	0,12	0,10	1,40
	Type III	0,04	0,12	0,10	1,60

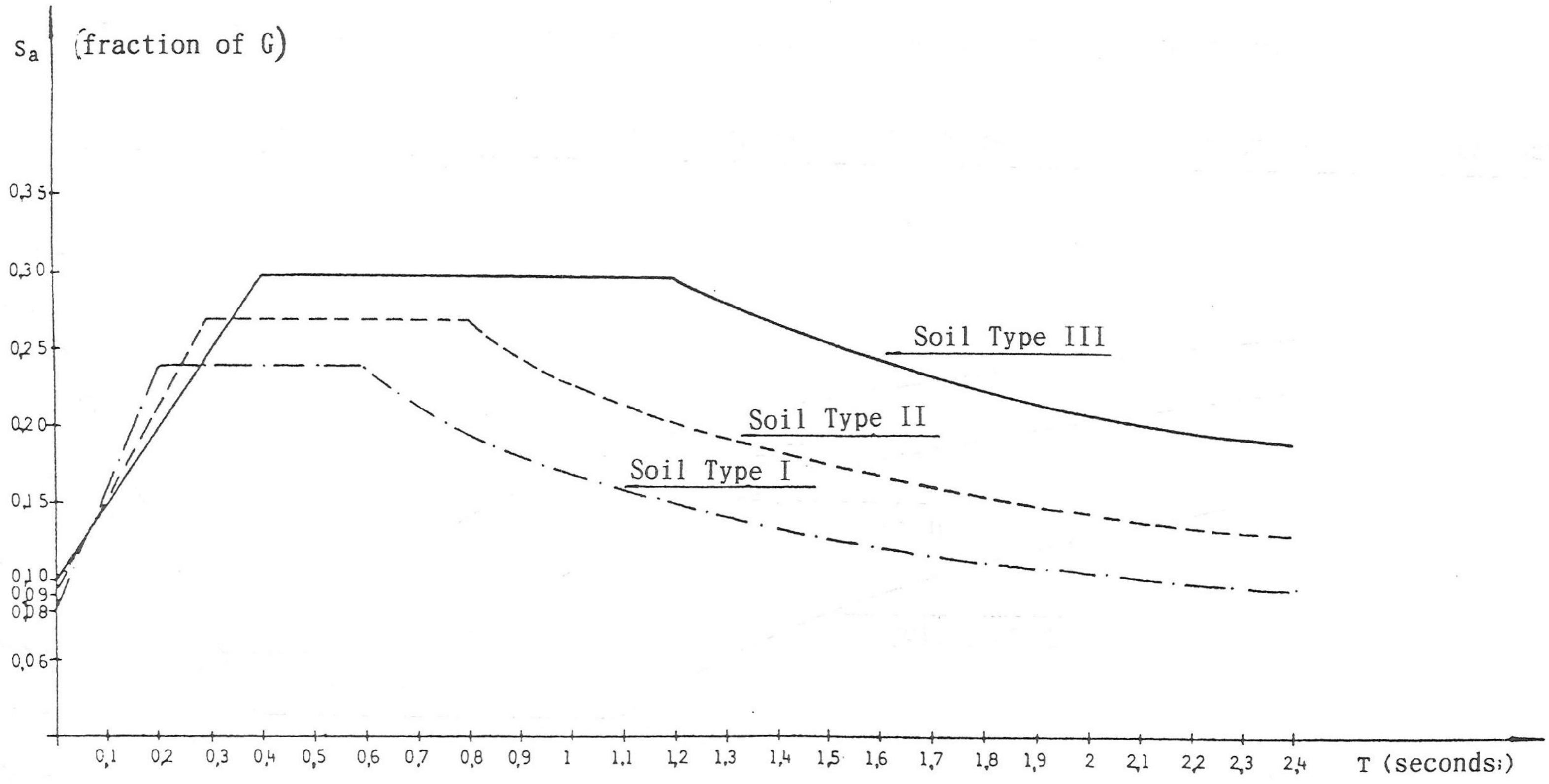

Figure 2 Elastic acceleration response spectrum for the seimic zone 1 with ξ = 5%

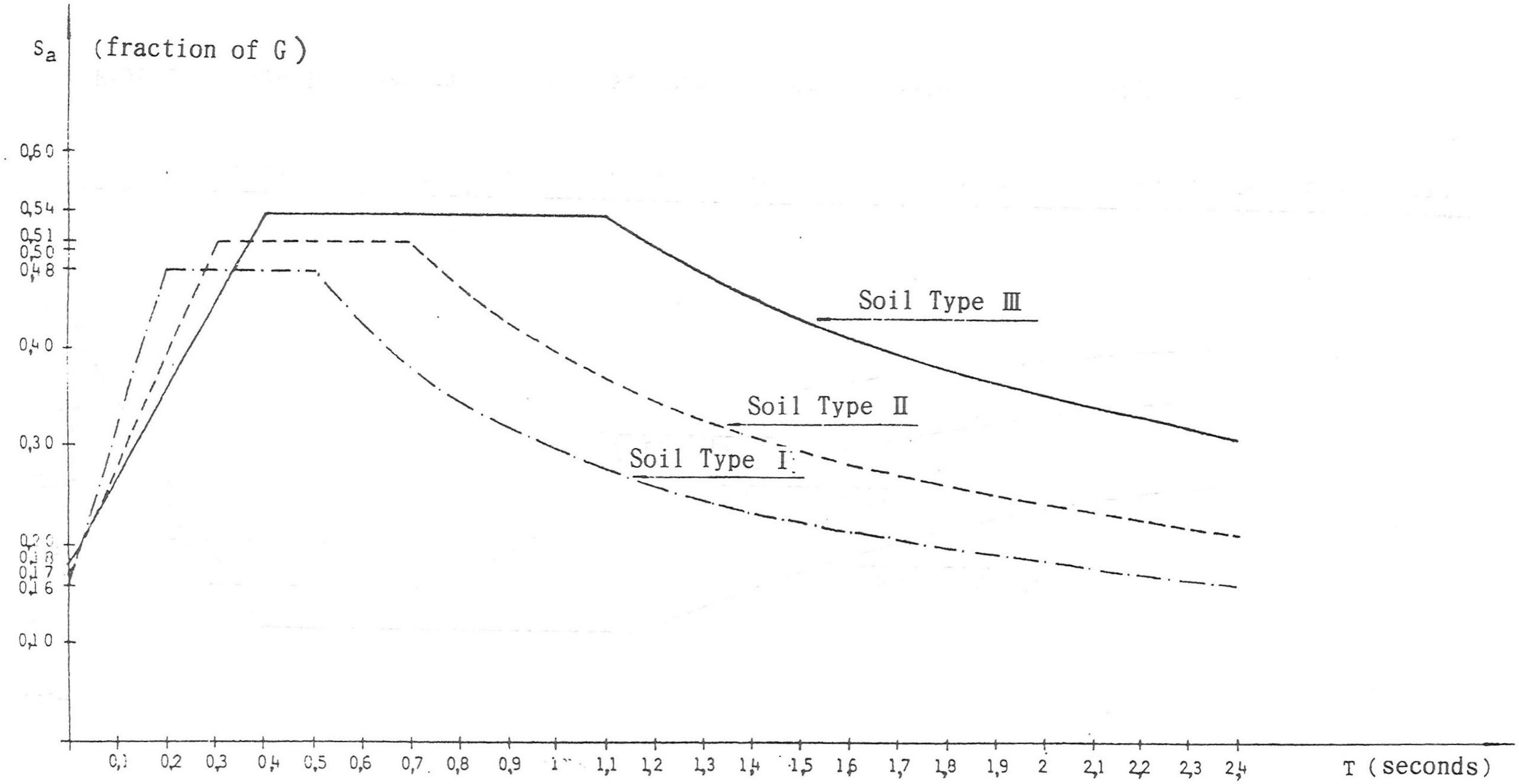

Figure 3. Elastic acceleration response spectrum for the seismic zone 2 with ξ =5%

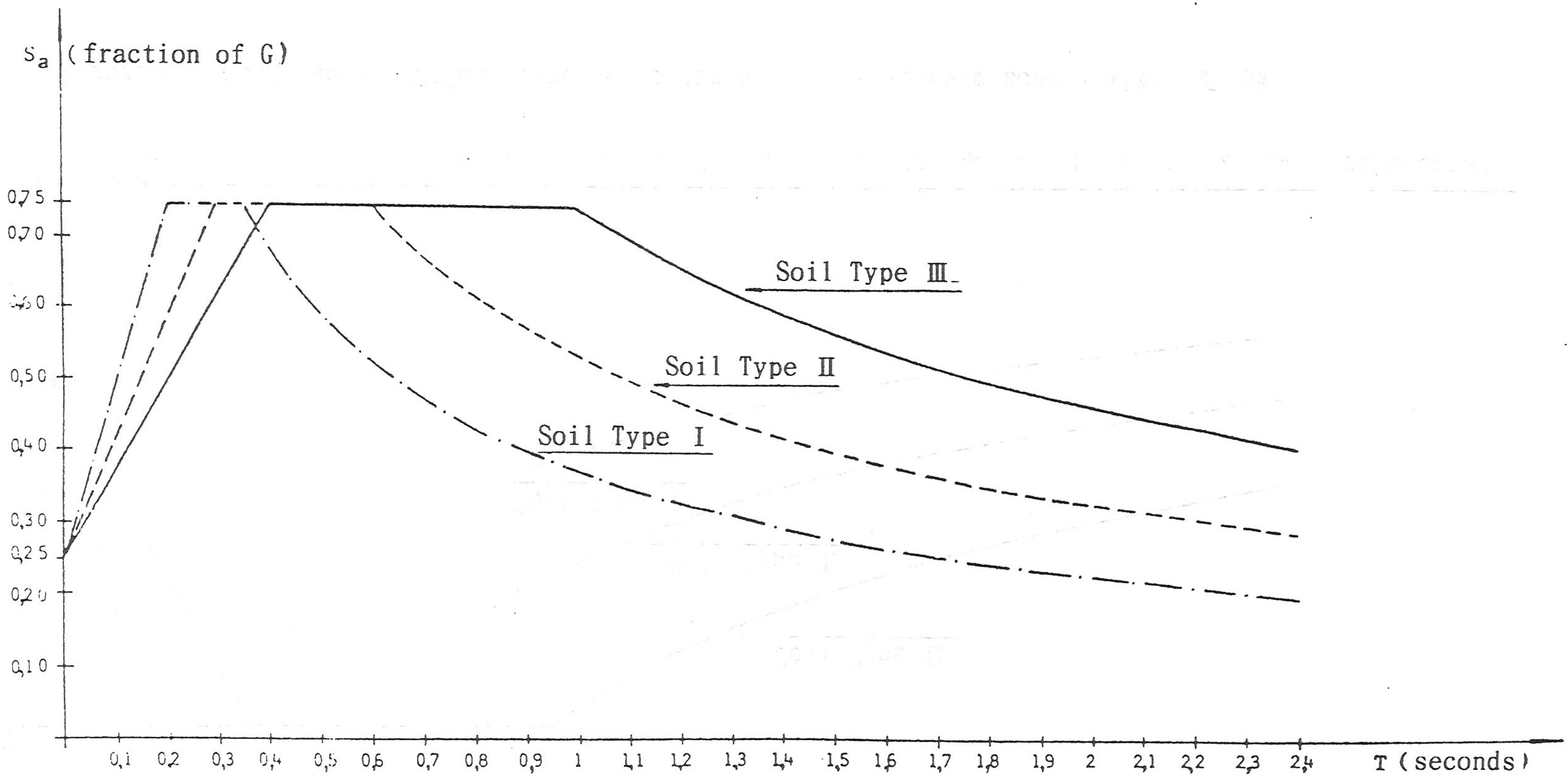

Figure 4. Elastic acceleration response spectrum for the seismic zone 3 with ξ =5%

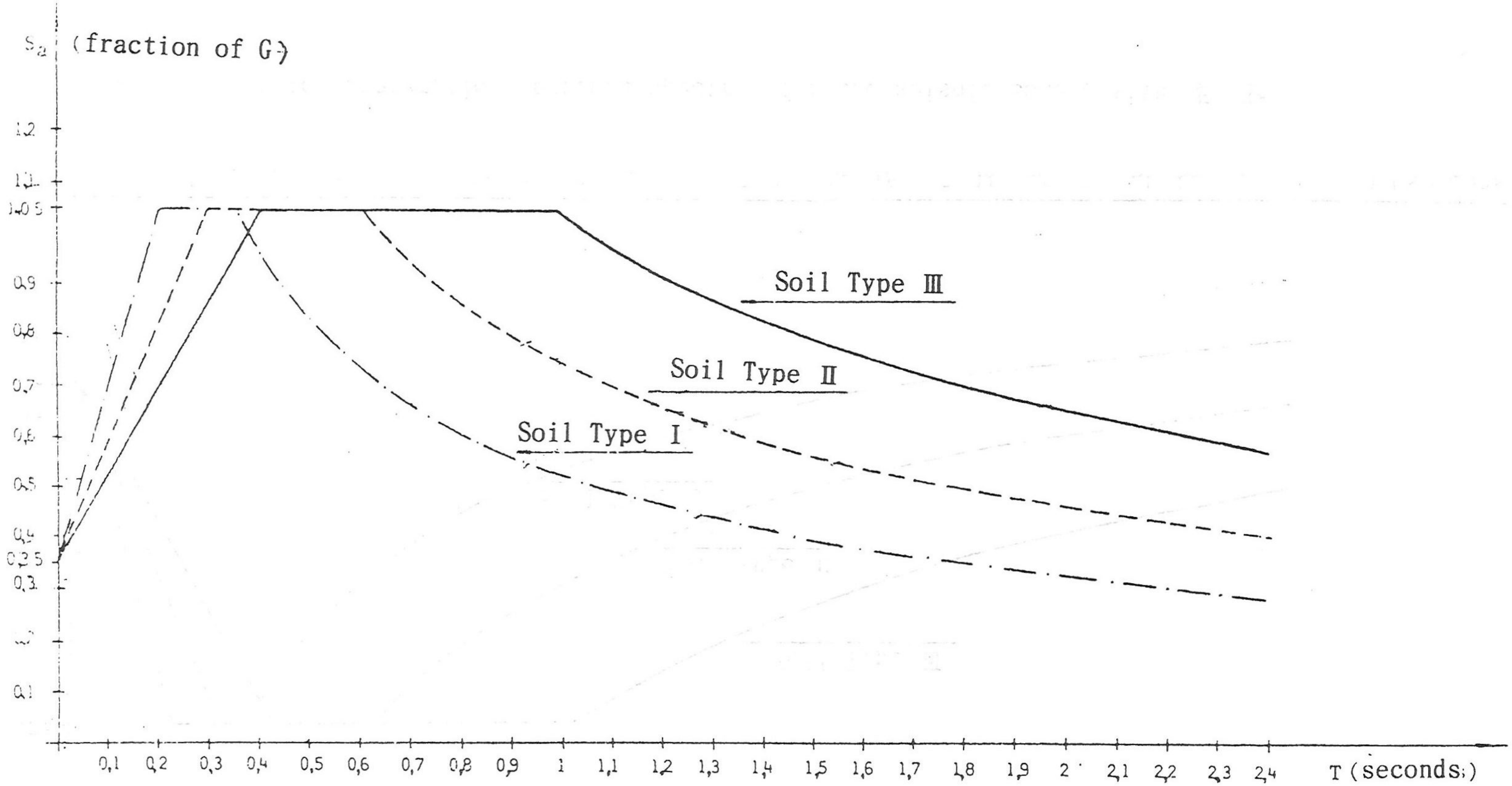

Figure 5. Elastic acceleration response spectrum for the seismic zone 4 with $\xi = 5\%$

7.3. VERTICAL SEISMIC ACTIONS

When the vertical seismic actions might be necessary to consider, the corresponding spectra would be obtained multiplying the spectral coordinate values for horizontal seismic actions by a factor f_v established in Table 5 in function of the seismic zone, through the following expression:

$$S_{av} = f_v . S_a$$

Where:

- S_{av} the coordinate of the design spectrum for vertical actions;
- f_v a factor given in Table 5;
- S_a the coordinate of the design spectrum for horizontal actions.

7.4. DETERMINATION OF THE SEISMIC DESIGN FORCES

For the determination of the seismic design forces, the ordered of the previously defined spectra will be reduced dividing by the factor R that considers the capacity of energy dissipation and static redundancy of the structures, according to what was established in the Chapter 8.

Table 5. Values of the factor f_v in function of the seismic zone.

SEISMIC ZONE	f_v
4	0.6
3	0.6
2	0.5
1	0.4
0	0.4

Editorial Notes This is an informal English translation prepared by the editorial members. The editors appreciate the help of Mr. Edwin J. Romero of Tokyo University.