MINISTÉRIO DAS OBRAS PÚBLICAS, TRANSPORTES E COMUNICAÇÕES

Laboratório Nacional de Engenharia Civil

DEPARTAMENTO DE ESTRUTURAS

Núcleo de Engenharia Sísmica e Dinâmica de Estruturas

Proc. 0305/17/15525

BUILDING STOCK INVENTORY AND VULNERABILITY DATA FOR LISBON METROPOLITAN AREA

RELATÓRIO 423/2005 - NESDE

Lisbon, August 2005

Project LESSLOSS – Risk Mitigation for Earthquakes and Landslides, Sixth Programme for Research, Technological Development and Demonstration of European Comission

Contract No.: GOCE-CT-2003-505448

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ESTRUTURAS

Building stock inventory and vulnerability data for Lisbon Metropolitan Area

Abstract

The present report addresses the first twelve months of LNEC participation in *LESSLOSS – Risk Mitigation for Earthquakes and Landslides* that is an European integrated project. Activities regarding subproject 10, *Earthquake disaster scenario predictions and loss modelling for urban areas,* are described, namely in what concerns deliverable nº81 that deals with building stock data and seismic vulnerability for Lisbon Metropolitan Area.

The LNECloss seismic loss methodology integrated in a Geographic Information System is presented, detailing available data and procedures.

Building stock for the Metropolitan Area of Lisbon (MAL) is characterized, based on building structure and epoch of construction. Some pictures are presented as examples of each class of building structure existing in Lisbon.

The vulnerability classification of the MAL housing stock is developed according to FEMA& NIBS methodology.

The LNECloss stochastic methodology was described and proved to be an equivalent approach to FEMA&NIBS displacement-based assessment.

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1 - INTRODUCTION

The project LESSLOSS – Risk Mitigation for Earthquakes and Landslides is a European integrated project developed within the framework of the Sixth Programme for Research, Technological Development and Demonstration of European Comission.

The project started in September, 2004, has a duration of 36 months, is coordinated by University of Pavia (Italy) and involves the participation of 46 European institutions.

Summarizing LESSLOSS objectives, it aims to promote a coordinated approach to the assessment of seismic risk, its environmental, urban and infrastructural impact, and prevention and protection strategies [Calvi & Pinho, 2004]. The LESSLOSS project addresses natural disasters, risk and impact assessment, natural hazard monitoring, mapping and management strategies, improved disaster preparedness and mitigation, development of advanced methods for risk assessment, methods of appraising environmental quality and relevant pre-normative research [Calvi & Pinho, 2004].

The LESSLOSS is a multidisciplinary project divided in eleven Research Components or Subprojects.

The National Laboratory for Civil Engineering (LNEC) is involved in the sub project 5 - In-situ – assessment, monitoring and typification of buildings and infrastructure and in the subproject 10 - Earthquake disaster scenario predictions and loss modelling for urban areas.

Globally, LNEC participation in subproject 10 involves the following tasks:

Task 1 – To present the data available for Lisbon on earthquake catalogues, seismotectonic environment, and site geology. To investigate and purpose possible strengthening techniques for non-ductile RC and Unreinforced Masonry buildings.

Task 2 – To develop scenario earthquakes for Lisbon site based on seismic deaggregation.

Task 3 – To present building inventory for Lisbon site based on Portuguese CENSOS 2001.

Task 4 – To present capacity curves fitting building inventory and compare them with Risk-EU for possible adjustments.

Task 5 – To adapt LNECloss software tool, that is an automatic seismic scenario loss estimate methodology, in order to re-evaluate loss estimation for specific mitigation policies.

The present report addresses the first 12 months of LNEC participation in subproject 10, namely deliverable nº 81 that deals with building stock data and seismic vulnerability for Lisbon Metropolitan Area.

Chapter 2 presents the LNECloss seismic loss methodology integrated in a Geographic Information System, its overview, procedures and available data, also presented in the 6 moths report.

Chapter 3 summarises the characterization of building stock for the Metropolitan Area of Lisbon (MAL), based on building structure and epoch of construction. It is presented some pictures as examples of each classe of building structure existing in Lisbon.

Chapter 4 presents the vulnerability classification of the MAL housing stock, according to FEMA& NIBS methodology.

Chaper 5 describes the LNECloss stochastic methodology that was proved to be an equivalent approach FEMA&NIBS displacement-based assessment.

Final and general considerations are reported in Chapter 6.

2 - LNECLOSS COMPUTER TOOL

2.1 - OVERVIEW

The LNECloss tool [Sousa *et al.,* 2004] *is* an automatic seismic scenario loss estimate methodology, integrated on a GIS (ArcGIS, or other) that comprises several modules to perform seismic risk analysis. This modules are developed in an high level programming language and compiled in DLL (Dynamic Link Library-DLL) that may be accessed rather efficiently by any Windows program environment (ArcView, EXCEL, MathLab, etc.). The several modules are schematically represented in figure 2.1 and are the following:

Bedrock Seismic Input - Given a seismic scenario (magnitude and epicentral location) it computes the Power Spectral Density Function (PSDF) of the strong ground motions at bedrock level of any site at a given epicentral distance.

The possibility of finite-fault modeling of seismic input at bedrock level was already implemented in LNECLoss computer codes. This work was also performed in the framework of LessLoss under SP10 in sub-task 2 *–scenarios earthquake definitions for three cities* and presented in D80 [INGV, 2005].

Local Soil Effects - Given a stratified soil profile units it computes the new PSDF for any location at the surface level, taking into account the nonlinear behavior of the stratified geotechnical site conditions.

Vunerability Analysis - Giving the PSDF at surface level, it computes the response of building typologies following an equivalent displacement-based methodology based on the capacities curves.

Fragility Analysis - For a particular site, taking into account damage observed in each typology, the number of existing buildings in each typology (inventory) and respective occupancy, it computes number of building in each damage state.

Human Losses - Taking into account damages in each typology and the occupancy per typology it computes human casualties and homeless.

Economic Losses - Taking into account damages in each typology and damage state it computes building floor lost areas, that can be multiplied by the repair and replacement cost to obtain economic losses.

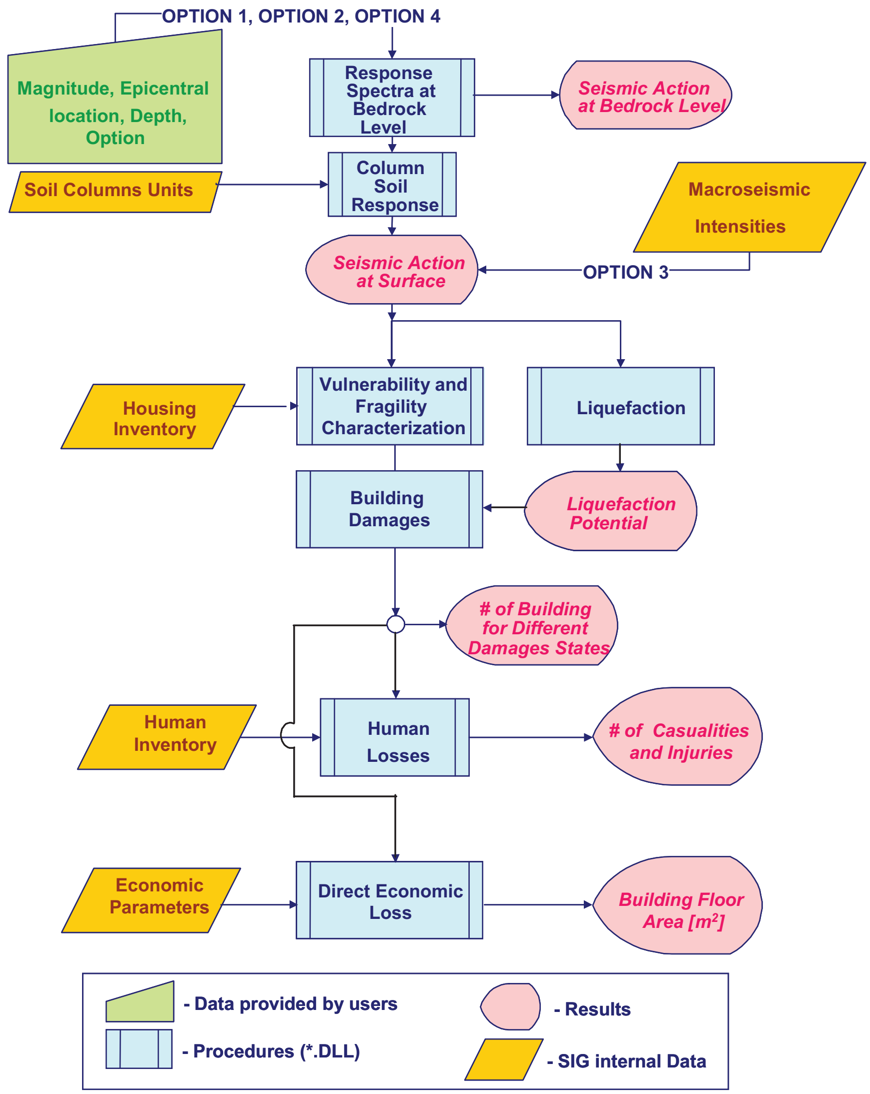


Figure 2.1: General diagram of LNECloss procedures.

2.2 - INPUT DATA

Generally speaking the required input data to LNECloss operation includes:

Shallow Geology – Data Base containing information on stratified soil profile units for the region under analysis. Each record comprises the thickness of shallow layers, shear waves velocity, density and plasticity index.

Building stock – Residential building database, geographically desegregated by small administrative divisions (parishes), surveyed in the Portuguese 2001 Censos [INE, 2003] and classified by epoch of construction, building construction materials and number of floors.

Population at risk - Inhabitants database, with the same level of geographic desegregation (parishes), surveyed in the Portuguese 2001 Censos [INE, 2003]. This database settles accounts for the number of inhabitants living in buildings classified according to their age, structural elements and height.

Economic parameters – Average floor areas, repair and replacement costs by parish. It was assumed an unique value of average floor areas inside MAL. Replacement cost follows building official prices established by law: *Portaria* nº 1062-C/2000, 31th of October, decrees the values of 461,4, 509,3 e 582,6 Euros/m^2 for the year of 2001, for specified counties in Portugal.

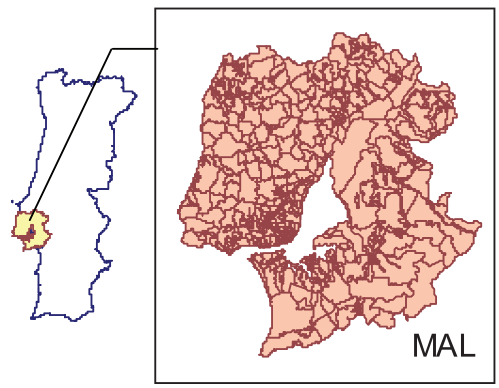
Data provided by user - The user should provide the following information: (i) x, y coordinates of the scenario epicentre in a rectangular (planar) coordinate system, (ii) the scenario magnitude and (iii) the option to evaluate seismic intensities in each site (see the following section).

This report will deal only with building stock and vulnerability characterization of Metropolitan Area of Lisbon (MAL) and presents the basic methodology implemented in LNEClosse computer tool to assess damage of buildings. Modules of LNECloss referring to seismic action at bedrock and site effects can be found in D80 [INGV,2005].

3 - CHARACTERIZATION OF *MAL* BUILDING STOCK

This report deals with building stock of MAL, meaning residential building database, geographically desegregated by small administrative divisions (parishes), surveyed in the Portuguese 2001 Censos [INE, 2003] and classified by epoch of construction, building construction materials and number of floors. The geographic location in Portuguese territory and general global statistics of MAL region is given in the Figure 3.1 below.

Global Statistics 2001	
Parishes	277
Geotechnical profiles	35
Subdivided parishes	405
Building classes	49
Building stock	477 170
Dwellings	1 389 236
Population	2 841 067



Economy: ≈ 40% of PIB of Portugal (130 000 M€)

Figure 3.1 – MAL global statistics and geographic location.

The *MAL* region distribution of population and building stock is characterized by coexistence of big concentration of population in some counties (Lisboa, Amadora, Setúbal, Sintra) with rural regions with poor concentration of inhabitants (Benavente, Alcochete, Salvaterra). Although industrial facilities are spread in the entire MAL region, there exist several industrial centres, namely; Lisbon, Barreiro, Seixal and Setúbal.

As a final result the MAL region can be regarded with some geographic heterogeneity in the social economic pattern distribution, common to other big cities in Mediterranean region like Athens and Barcelona.

This gives rise to some difficulties in the building stock classification and typification. In Figure 3.2 presents the building stock of MAL, based on building structure and epoch of construction, without taking into account the number of floors.

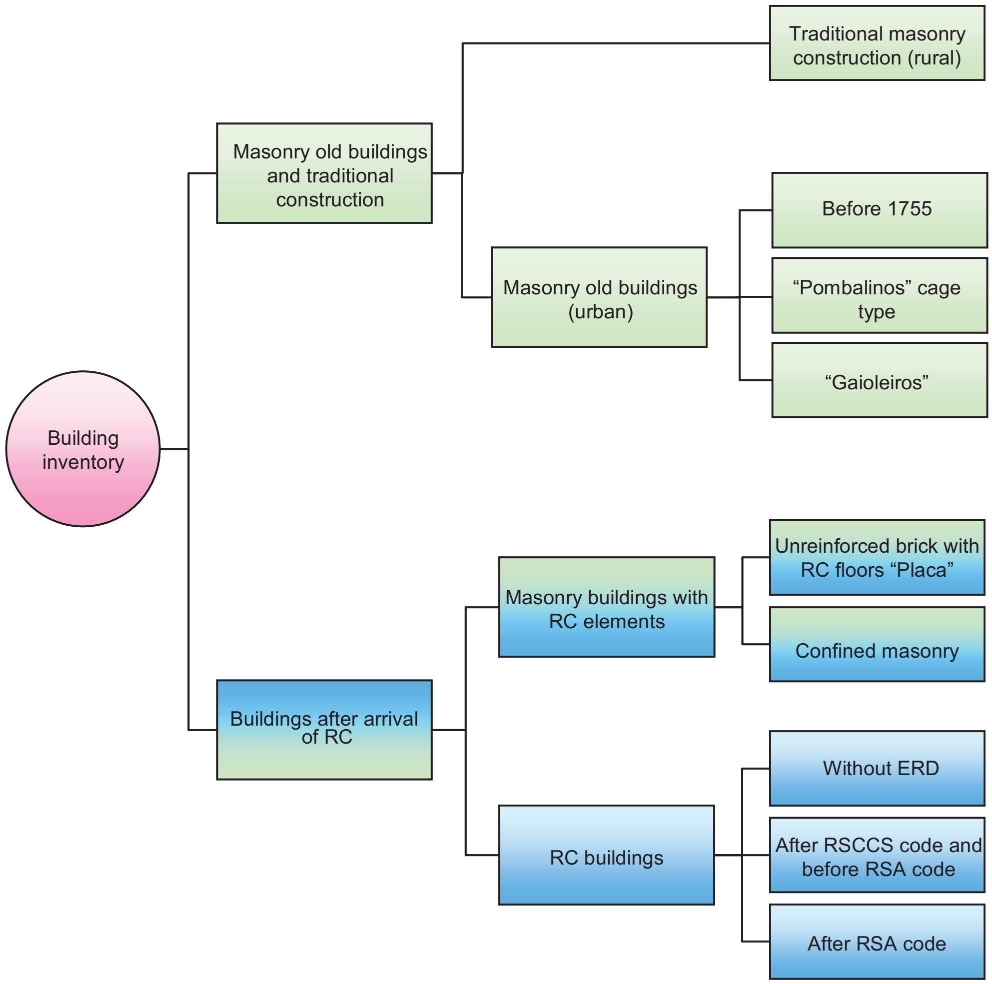


Figure 3.2 – Building stock of MAL, based on building structural practices [adapted from Sousa, 2005].

As presented in figure 3.2, the building stock was divided into

I) Masonry old buildings and traditional construction:

i) Traditional masonry construction.

Low rise (one or two storey high) rural rubble limestone or adobe constructions with heavy roofs with clay tile supported by wooden structures. This is rural construction that is not very common in MAL (9%)

ii) Buildings constructed before 1755 Lisbon earthquake, figure 3.3.

Old masonry buildings that where not completely destroyed or demolished after 1755 earthquake.

Figure 3.3 – Masonry old buildings, before 1755.

iii) Buildings constructed after 1755 Lisbon earthquake (1755 – 1880) - "Pombalinos" cage type, figure 3.4

Well identified masonry building constructions found in downtown Lisbon characterized by the existence of a stand alone spatial wooden frame structure deemed to absorb the seismic forces by linking the masonry structural walls.

Figure 3.4 – Masonry old buildings,"Pombalinos" cage type [after Sousa, 2005].

iv) “Gaioleiros” (1880 – 1930), figure 3.5

Type of masonry construction with timber floors, varying from 2 to 5 storeys high, built in accordance with current construction practice spread all over Europe at those times. This structural type is mainly present in the Lisbon and in the other more heavily populated regions of MAL. It differs from the “Pombalinos” because timber structural elements, embedded in some walls, are not completely connected to form an independent spatial timber frame. Moreover in this type of structure, walls are slender and higher.

Figure 3.5 – Masonry old buildings, “Gaioleiros” [after Sousa, 2005].

II) Buildings after arrival of RC

i) Masonry buildings with unreinforced brick with RC floors, figure 3.6.

Masonry buildings with concrete slabs built during and before the Second World War in the thirty until the fiftieth decades. Some vertical concrete structural elements (walls or columns) can also be found. In general terms masonry walls are of better quality then the ones present by “Gaioleiros”. Partitions are of solid clay bricks with a good resistance.

Figure 3.6 – Masonry buildings with unreinforced brick with RC floors, "placa" in bad state of preservation.

ii) Confined masonry, figure 3.7

Low rise brick masonry dwellings (1 to 2 storeys high) in which reinforced concrete frame elements (lintels and piers) are constructed in the openings, or against, of the brick walls panels erected in advance. Floors are in most of the cases constructed with prefabricated beam-slab systems and clay units with a thin steel mesh reinforced cover.

Figure 3.7 – Confined masonry building [after Sousa, 2005].

iii) RC buildings without Earthquake Resistant Design (ERD),

Generally known as the non-ductile reinforced concrete frame structure. This structural type is not very common in MAL representing around 6% of the stock.

iv) RC buildings after RSCCS code and before RSA code, figure 3.8

Medium rise and low level of earthquake resistant design reinforced concrete frame structural systems. Designed for horizontal loads, less then 10% seismic coefficient. They were constructed from the sixties until mid eighties.

Figure 3.8 – RC buildings after RSCCS code and before RSA [after Sousa, 2005].

v) RC buildings constructed after RSA code enforce, figure 3.9

Medium and high rise concrete structures built after 1985, seismically designed according to modern seismic codes. Generally they are reinforced concrete ductile frame, wall or dual structural systems.

Figure 3.9 – RC buildings constructed after RSA code being enforce. Left: RC frame building; Righ: RC dual systems [after Sousa, 2005].

Sousa [2005] analyzed the 2001 Portuguese Censos with three main purposes: (i) to build the statistics of the number of buildings and inhabitants in Portuguese mainland, (ii) to characterize their geographic distribution and (iii) to identify the most representative and frequent building types by region.

In the Building Questionnaire of that Censos there were identified some variables representing buildings characteristics that are expected to influence their performance when stricken by an earthquake: epoch of construction; building structure; number of floors. Table 1 presents the classes of those variables available in Censos 2001.

Figures 3.10 to 3.13 present the histograms of number of buildings in MAL according to those vulnerability variables.

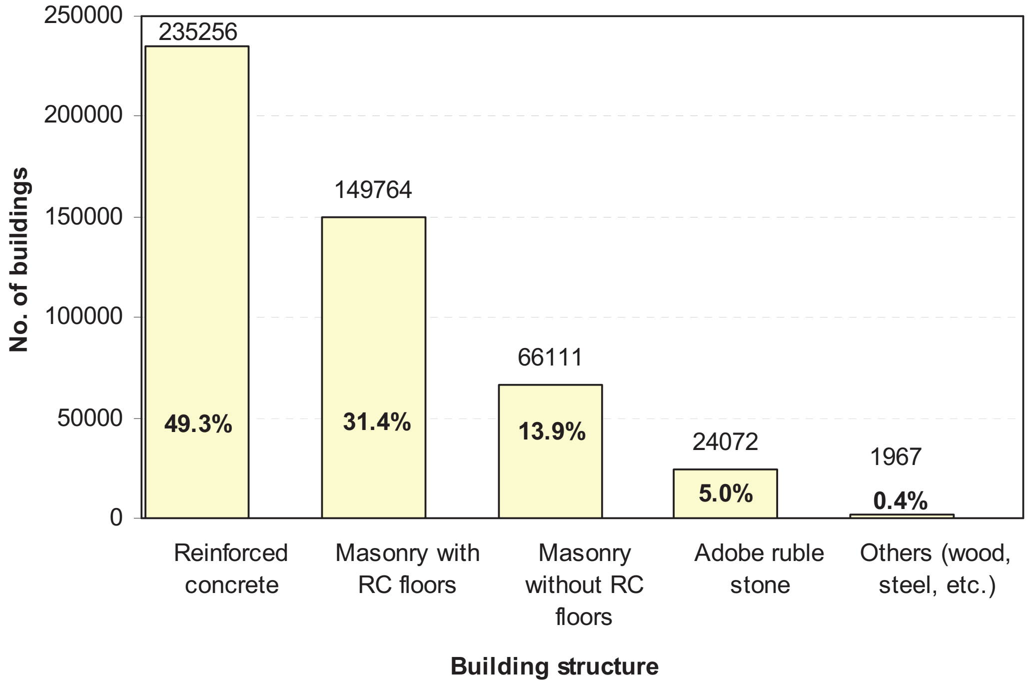


Figure 3.10: Number of buildings per structural typology in MAL.

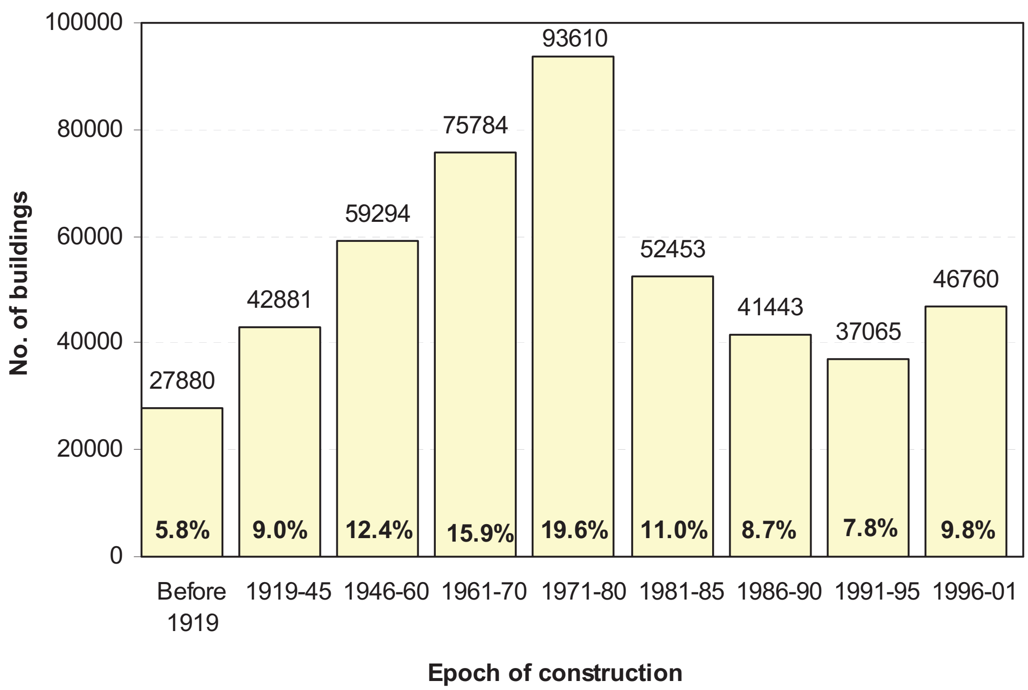


Figure 3.11: Number of buildings per epoch of construction in MAL.

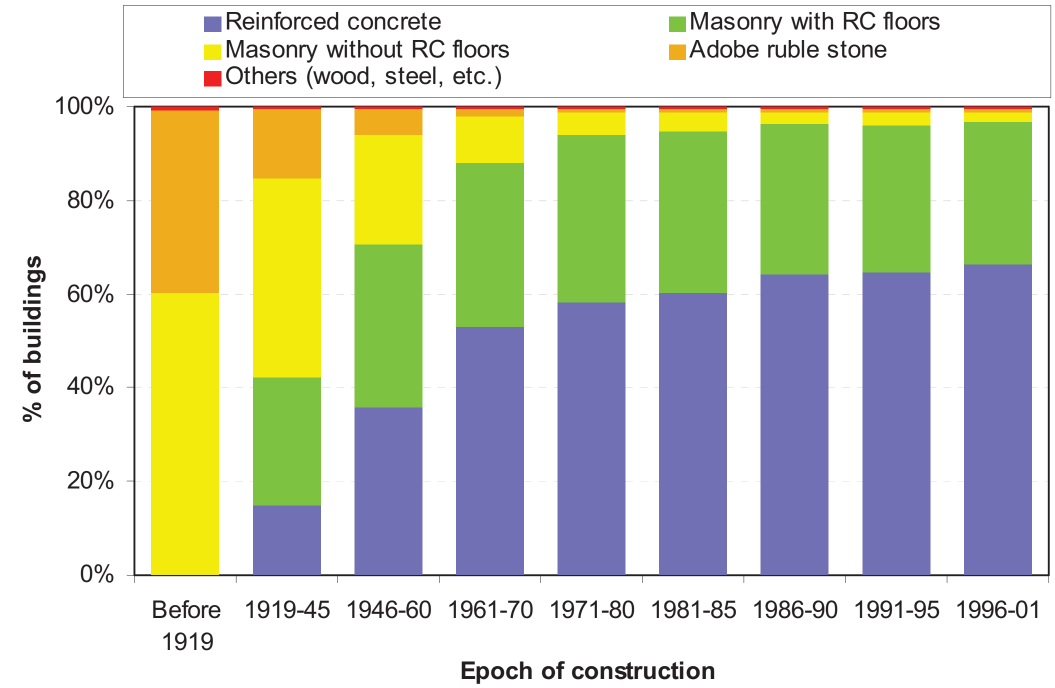


Figure 3.12: Percentage of buildings per structural typology given the epoch of construction in MAL.

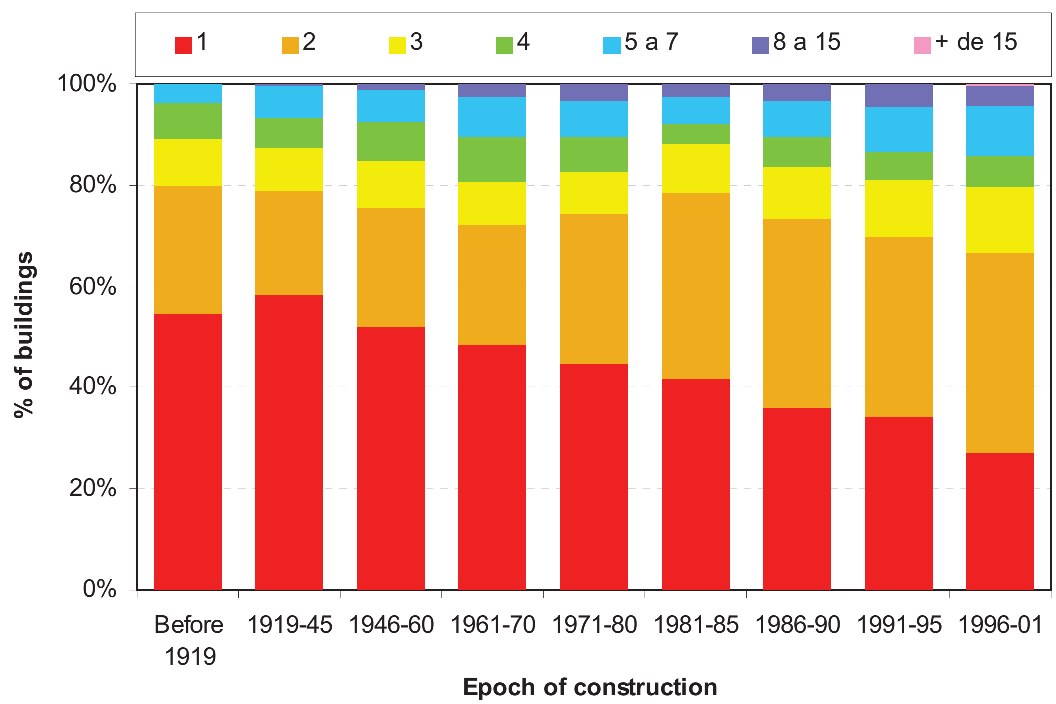


Figure 3.13: Percentage of buildings per number of floors given the epoch of construction in MAL.

4 - VULNERABILITY CHARACTERIZATION

Carvalho et al. [2002a] established a typological classification of Portuguese building stock taking into account a first analysis of Portuguese Census 1991 and expert opinion. Experts gave information on the most relevant building practices in the Country, materials and technologies employed in construction, their evolution over time and space. The history of building seismic upgrade in Portugal is mainly related to the occurrence of earthquake disasters (eg. 1755 earthquake) or to the enforce of building codes.

The authors identified seven typological classes allowing for the two Census 1991 variables Epoch of construction and Resistant elements. Each of those classes was further subdivided in seven categories, considering building height, leading to forty-nine building types with similar seismic response characteristics. For those 49 typologies of buildings Carvalho et al. [2002b] proposed capacity (pushover) and fragility curves, with a view to a future implementation of a performance-based procedure for the evaluation of building damages.

Those 49 typologies are now updated taking into account the new features included in Census 2001, namely a more reliable classification of the building structure.

A typological classification of Portuguese building stock taking into account the referred analysis on Portuguese Censos 2001 was established. Table 4.1 presents number of buildings in MAL per epoch of construction, structural type and number of floors after analysing Censos 2001.

Table 4.2 presents the vulnerability classification of the MAL housing stock, according to FEMA & NIBS [1999] methodology. This methodology will be described in the next chapter.

Figure 4.1 shows the percentage of buildings per FEMA & NIBS structural types in MAL and figure 4.2 presents seismic vulnerability maps for MAL according to FEMA & NIBS classification.

The criteria used to establish the correspondence between Censos 2001 classification and the structural types where based on the past experience and expert opinion of LNEC researchers as already mentioned. Note, for instance, that in table 4.2 although buildings higher then 5 storey, that were built after the sixties, were classified according to Censos 2001 as *Masonry with RC floors* it was decided to classify them as *RC buildings after RSCCS code and before RSA* (RC 1960-1885) or *RC buildings constructed after RSA code enforce* (RC 1985-2001). This is clear a common sense criterion based on the knowledge of the Portuguese construction industry practice.

Table.4.1 – Number of buildings in MAL per epoch of construction, structural type and number of floors (Censos 2001) [adapted from Sousa, 2005].

Epoch	No. of floors	RC	Masonry w/ RC floors	Masonry w/t RC floors	Adobe + ruble stone	Others (wood, steel,)
Before 1919	1	0	0	7 911	7 211	151
	2	0	0	4 015	2 980	46
	3	0	0	1 918	661	14
	4	0	22	1 846	0	19
	5 a 7	0	5	1 069	0	12
	8 a 15	0	0	0	0	0
	+ de 15	0	0	0	0	0
	Total	**0**	**27**	**16759**	**10852**	**242**
1919 to 1945	1	3159	5949	10613	5175	124
	2	1270	2677	3830	1055	14
	3	721	1032	1712	185	10
	4	514	769	1259	0	12
	5 a 7	480	1391	738	0	3
	8 a 15	188	0	0	0	1
	+ de 15	0	0	0	0	0
	Total	**6332**	**11818**	**18152**	**6415**	**164**
1946 to 1960	1	7548	10428	9836	2923	124
	2	5188	5693	2504	483	16
	3	2795	1955	604	100	8
	4	2759	1394	512	0	2
	5 a 7	2167	1369	223	0	4
	8 a 15	659	0	0	0	0
	+ de 15	0	0	0	0	0
	Total	**21116**	**20839**	**13679**	**3506**	**154**
1961 to 1970	1	13662	15580	6206	1001	207
	2	9637	7089	968	193	13
	3	4720	1711	213	36	4
	4	5418	1106	166	0	2
	5 a 7	4791	1024	68	0	2
	8 a 15	1893	0	0	0	0
	+ de 15	74	0	0	0	0
	Total	**40195**	**26510**	**7621**	**1230**	**228**
1971 to 1980	1	18318	18822	3730	547	366
	2	16604	10489	588	138	24
	3	5291	2133	217	23	1
	4	5373	1010	87	0	3
	5 a 7	5878	839	48	0	2
	8 a 15	2944	0	0	0	0
	+ de 15	133	0	0	0	2
	Total	**54541**	**33293**	**4670**	**708**	**398**
1981 to 1985	1	10135	9373	1715	279	263
	2	12367	6710	270	90	23
	3	3471	1349	68	17	4
	4	1740	365	34	0	6
	5 a 7	2514	358	22	0	3
	8 a 15	1202	0	0	0	4
	+ de 15	71	0	0	0	0
	Total	**31500**	**18155**	**2109**	**386**	**303**
1986 to 1990	1	7537	6271	896	178	127
	2	9746	5320	181	82	19
	3	3303	962	35	12	2
	4	2138	319	19	0	0
	5 a 7	2621	341	15	0	0
	8 a 15	1260	0	0	0	1
	+ de 15	58	0	0	0	0
	Total	**26663**	**13213**	**1146**	**272**	**149**
1991 to 1995	1	6260	5424	640	215	146
	2	8394	4574	205	82	26
	3	3095	918	66	16	2
	4	1700	316	28	0	2
	5 a 7	2828	470	21	0	2
	8 a 15	1575	0	0	0	0
	+ de 15	60	0	0	0	0
	Total	**23912**	**11702**	**960**	**313**	**178**
1996 to 2001	1	6428	5243	610	219	110
	2	11445	6601	234	144	25
	3	4584	1363	85	27	8
	4	2391	553	54	0	3
	5 a 7	4061	447	32	0	4
	8 a 15	1984	0	0	0	1
	+ de 15	104	0	0	0	0
	Total	**30997**	**14207**	**1015**	**390**	**151**
Total	**Tip. Struct.**	**235256**	**149764**	**66111**	**24072**	**1967**
1 floor	**2 floors**	**3 floors**	**4 floors**	**5 a 7 floors**	**8 a 15 floors**	**+ de 15 floors**
211660	**142052**	**45451**	**31941**	**33852**	**11712**	**502**

Table 4.2 – Vulnerability classification of the Portuguese housing stock, with reference to Censos-2001 according to FEMA & NIBS typologies [after Sousa, 2005] .

Epoch	No. of floors	RC	Masonry with RC floors	Masonry without RC floors	Adobe + ruble stone	Others
Before 1919	1			1	1	1
	2			2 Adobe + ruble	2 Adobe + ruble	2 Adobe + ruble
	3			3 stone +	3 stone + Others	3 stone +
	4		11 Masonry	4 Others		4 Others
	5 a 7		12 ≤ 1960	5		5
	8 a 15					
	+ de 15					
1919 to 1945	1	29	8	8	1	1
	2	30	9	9	2 Adobe + ruble	2 Adobe + ruble
	3	31 RC ≤ 1960	10 Masonry	10 Masonry	3 stone + Others	3 stone +
	4	32	11 ≤ 1960	11 ≤ 1960		4 Others
	5 a 7	33	12	12		5
	8 a 15	34				48 RC 1986-01
	+ de 15					
1946 to 1961	1	29	8	8	1	1
	2	30	9	9	2 Adobe + ruble	2 Adobe + ruble
	3	31 RC ≤ 1960	10 Masonry	10 Masonry	3 stone + Others	3 stone +
	4	32	11 ≤ 1960	11 ≤ 1960		4 Others
	5 a 7	33	12	12		5
	8 a 15	34				48 RC 1986-01
	+ de 15					
1961 to 1970	1	36	15	15	1	1
	2	37	16 Masonry	16 Masonry	2 Adobe + ruble	2 Adobe + ruble
	3	38	17 1961-85	17 1961-85	3 stone + Others	3 stone + Others
	4	39 RC 1961-85	18	18		46
	5 a 7	40	40 RC 1961-85	40 RC 1961-85		47 RC 1986-01
	8 a 15	41				
	+ de 15	42				49 RC 1986-01
1971 to 1980	1	36	15	15	1	1
	2	37	16 Masonry	16 Masonry	2 Adobe + ruble	2 Adobe + ruble
	3	38	17 1961-85	17 1961-85	3 stone + Others	3 stone + Others
	4	39 RC 1961-85	18	18		46
	5 a 7	40	40 RC 1961-85	40 RC 1961-85		47 RC 1986-01
	8 a 15	41				48
	+ de 15	42				49
1981 to 1985	1	36	15	15	1	1
	2	37	16 Masonry	16 Masonry	2 Adobe + ruble	2 Adobe + ruble
	3	38	17 1961-85	17 1961-85	3 stone + Others	3 stone + Others
	4	39 RC 1961-85	18	18		46
	5 a 7	40	40 RC 1961-85	40 RC 1961-85		47 RC 1986-01
	8 a 15	41				48
	+ de 15	42				
1986 to 1990	1	43	22	22	1	1
	2	44	23 Masonry	23 Masonry	2 Adobe + ruble	2 Adobe + ruble
	3	45	24 1986-01	24 1986-01	3 stone + Others	3 stone + Others
	4	46 RC 1986-01	25	25		46
	5 a 7	47	47 RC 1986-01	47 RC 1986-01		47 RC 1986-01
	8 a 15	48				48
	+ de 15	49				
1991 to 1995	1	43	22	22	1	1
	2	44	23 Masonry	23 Masonry	2 Adobe + ruble	2 Adobe + ruble
	3	45	24 1986-01	24 1986-01	3 stone + Others	3 stone + Others
	4	46 RC 1986-01	25	25		46
	5 a 7	47	47 RC 1986-01	47 RC 1986-01		47 RC 1986-01
	8 a 15	48				
	+ de 15	49				
1996 to 2001	1	43	22	22	1	1
	2	44	23 Masonry	23 Masonry	2 Adobe + ruble	2 Adobe + ruble
	3	45	24 1986-01	24 1986-01	3 stone + Others	3 stone + Others
	4	46 RC 1986-01	25	25		46
	5 a 7	47	47 RC 1986-01	47 RC 1986-01		47 RC 1986-01
	8 a 15	48				48
	+ de 15	49				

Vulnerability classes						
Adobe + ruble stone + Outros	Masonry ≤ 1960	Masonry 1961-85	Masonry 1986-01	RC ≤ 1960	RC 1961-85	RC 1986-01

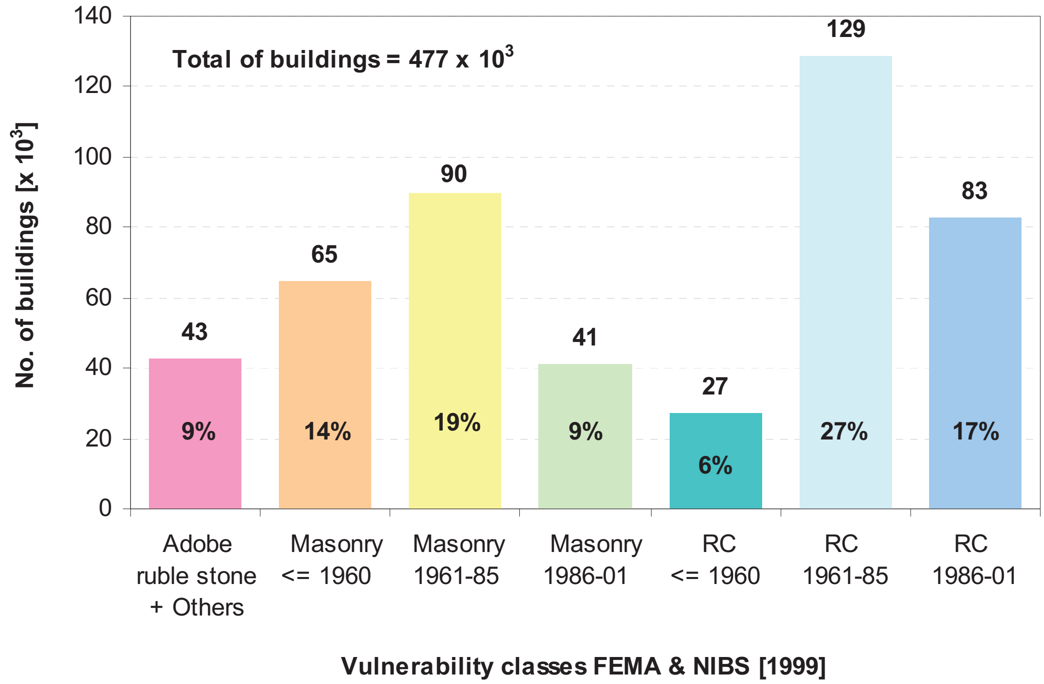


Figure 4.1 – Distribution of buildings per FEMA & NIBS vulnerability classes in MAL (Censos 2001) [adapted from Sousa, 2005].

Table 4.3 – Distribution of buildings per FEMA & NIBS typologies types in MAL (Censos 2001) [adapted from Sousa, 2005].

Type./ No.floors	Adobe + ruble stone + Others	Masonry ≤ 1960	Masonry 1961-85	Masonry 1986-01	RC ≤ 1960	RC 1961-85	RC 1986-01
1	27 277	36 826	55 426	19 084	10 707	42 115	20 225
2	9 468	14 704	26 114	17 115	6 458	38 608	29 585
3	3 048	5 303	5 691	3 429	3 516	13 482	10 982
4	1 879	3 956	2 768	1 289	3 273	12 531	6 245
5-7	1 088	3 726	0	0	2 647	15 542	10 849
7-15	0	0	0	0	847	6 039	4 826
+15	0	0	0	0	0	278	224
Total	42 760	64 515	89 999	40 917	27 448	128 595	82 936

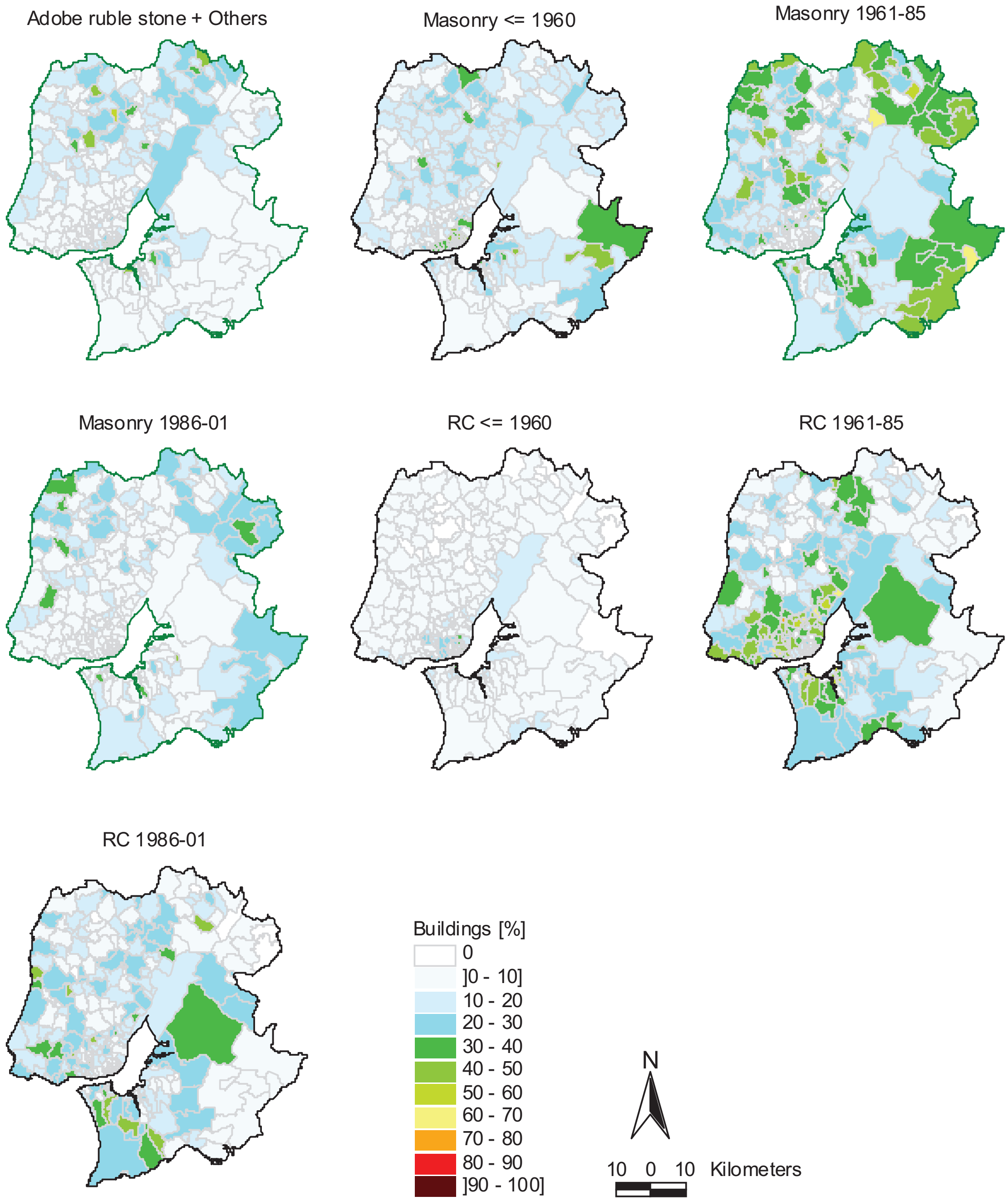


Figure 4.2– Seismic vulnerability maps for MAL according FEMA & NIBS classification.

5 - FEMA & NIBS METHODOLOGY- THE LNECLOSS APPROACH

The evaluation of peak response for each type of building relies on the intersection of its capacity curve with the seismic spectral demand at the site. This technique is called the "*capacity spectrum method*". ATC-40 and is worldwide divulged by the HAZUS [FEMA & NIBS 1999] loss estimation methodology.

The capacity spectrum method is based on performance-based procedures for the assessment of existing building structures and on the reduction of the *initial elastic response spectra* to the so called *demand spectra*, taking into account the degradation of the building exposed to the seismic motion. That procedure is iterative and is qualitatively depicted in figure 5.1.

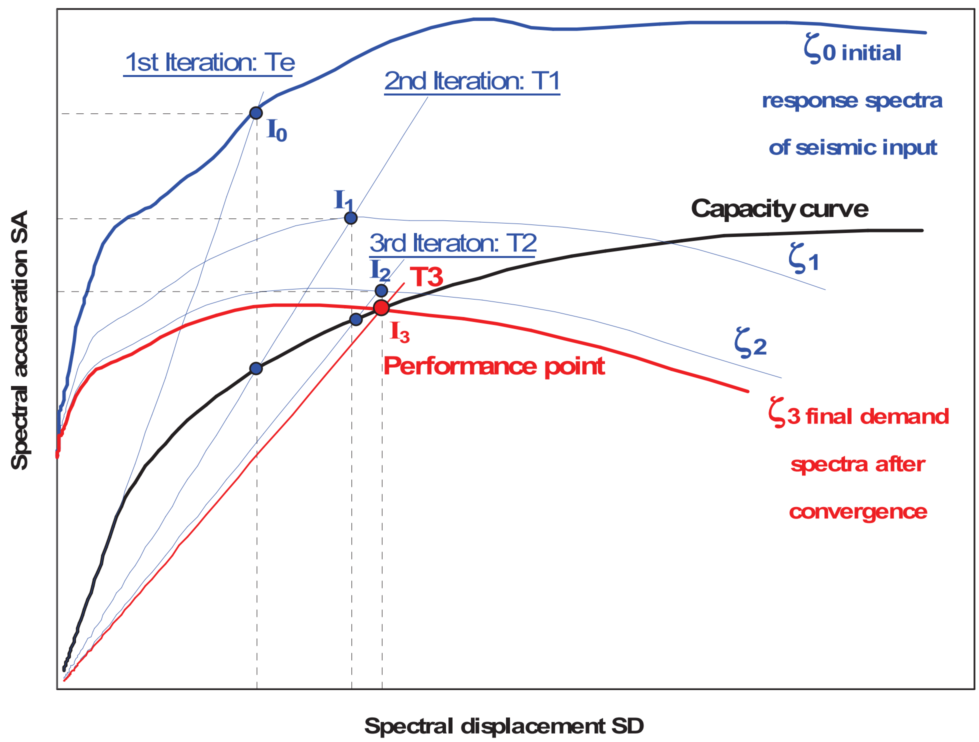


Figure 5.1 – Iterative methodology to obtain the peak of building response in FEMA.

An equivalent approach to the displacement base assessment to evaluate the *performance point* (see figure 5.1 above) was implemented in LNECloss code which can be better understood by analysing the flowchart depicted in figure 5.2.

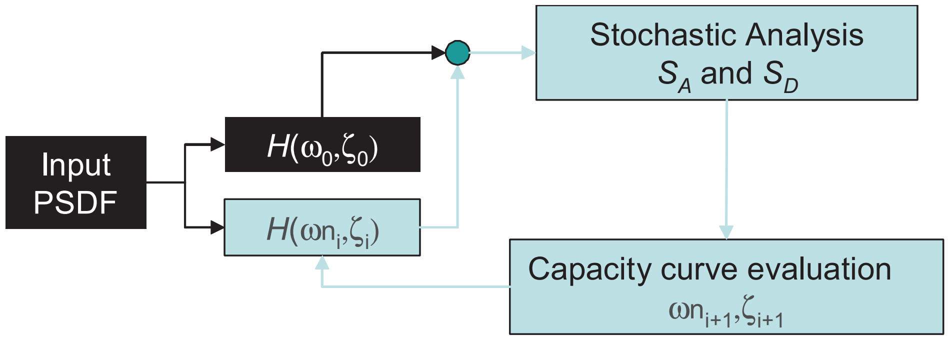


Figure 5.2 – Iterative methodology to obtain the peak of building response in LNECloss method: blue boxes correspond to iterative procedures; black boxes are initial evaluations.

That alternative equivalent scheme to compute the *performance point* starts with the definition of input motion in terms of a power spectral density function (PSDF) and an equivalent stationary time duration *T*. In general seismic input is defined as a response spectra, associated to some damping coefficient ζ, a linear stochastic approach was implemented in LNECloss to accomplish this transformation and was described in the D80 report [INGV, 2005], chapter 4 ("the case of metropolitan area of Lisbon"), section 4.4.2. ("surface sites scenarios").

Taking an initial value of natural frequency ω_0 of the structure and damping ratio ζ_0 it is possible to estimate the transfer function between input base motion and relative displacement $H(\omega_0,\zeta_0)$. The initial stiffness of the structure is computed taking into account the tangent line in the origin of the capacity curve; the mass of the structure associated with the first mode shape, and some low damping coefficient. This initial values are parameters that should be defined for each structural typology.

Using the concepts of linear stochastic dynamic analysis, structural responses, in terms of spectral relative displacements *SD* and absolute acceleration *SA* are evaluated in successive interactions until a convergence error is attained. The successive decreasing of the structural natural frequency ωn and increasing of damping ζ are evaluated by means of the capacity curve and applying the same procedure used by FEMA already illustrated in figure 5.1.

Once again the relative response displacement SD_i and absolute acceleration SA_i, using the transfer function $H(\omega_i,\zeta_i)$ and taking into account a given PSDF are described in the D80 report [INGV, 2005], chapter 4 ("the case of metropolitan area of Lisbon"), section 4.4.2. ("surface sites scenarios").

In general terms less than 5 iterations in the procedure shown in figure 5.2 are needed to obtain a performance point that does not vary from 1% in relation to the next iteration.

Finally the evaluation of damages is obtained multiplying the relative frequencies of the buildings in each damage state by the number of buildings for each typology in a given geographic unit.

Fragility curves allow the evaluation of the probability to exceed the threshold of a given damage state. As purposed by HAZUS 99 [FEMA & NIBS, 1999] five damage states were considered: *No damage*, *Slight*, *Moderate*, *Severe* and *Complete Damage*. The thresholds of those damage states are established in terms of global drift for each typology.

Figure 5.3 shows an example of the capacity curves and thresholds of damage states for one typology identified in Censos 2001. In Annex A to this report it is presented capacity and fragility curves and median values of damage state for all the typologies used in CENSOS 2001 for MAL region.

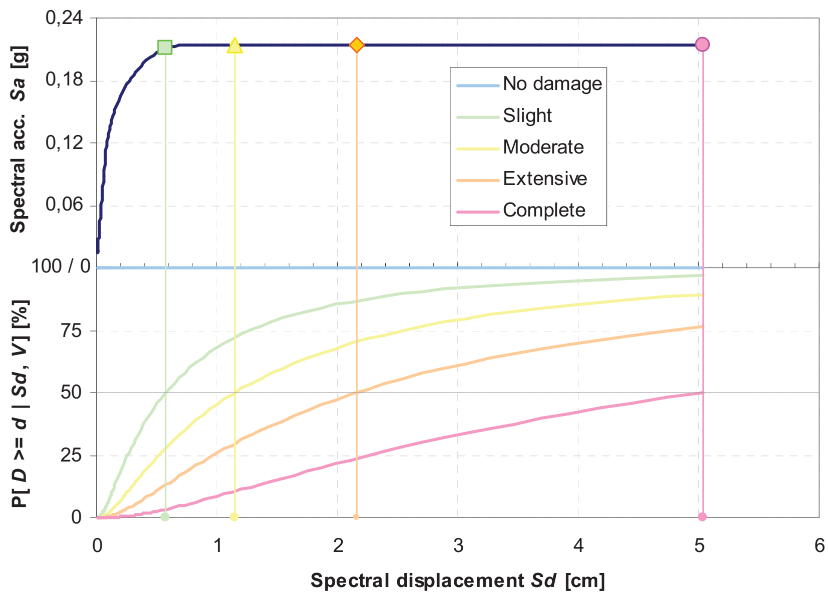


*Figure 5.3- Capacity curves example and fragility for structural type «**Adobe + ruble stone + Others**» with **1 floor.***

6 - FINAL CONSIDERATIONS

This report began with the presentation of LESSLOSS project Risk Mitigation for Earthquakes and Landslides, and describe the 12 months of LNEC participation in subproject 10 - Earthquake disaster scenario predictions and loss modelling for urban areas.

LNEC participation in subproject 10 includes the adaptation of LNECLoss software tool to revaluate seismic risk in region that comprises the Metropolitan Area of Lisbon MAL region before and after the virtually implementation of specific mitigation policies.

Building stock inventory, based on CENSOS 2001 was presented. Characterization of the main structural typologies that are presented in the area was described. The full vulnerability and fragility typification and quantification were also presented for all the MAL building stock.

Finally the equivalent nonlinear stochastic methodology adopted in LNECloos was presented with some detail. Although no comparison with FEMA&NIBS approach to compute the structural response (performance point evaluation) was carried out in the present study, previous studies weld in 2001 (Carvalho et al, 2001) have shown that both approaches are equivalent, which will be presented in futures deliverables of SP10.

Also as future work, within SP10, capacity curves and fragility characterization presented herein need to be compared, taking into account the developments of LESSLOSS project (SP 8) and previous EU funded projects like Risk-UE and SEISMOCARE. Damage probability matrices based on European earthquakes can also be used to calibrate vulnerability and fragility information.

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8 - ACKOWLEDGMENTS

The authors are very thankful to Dra. Anabela Martins that provided computation support to the development of this report.

Lisbon, National Laboratory for Civil Engineering, August 2005

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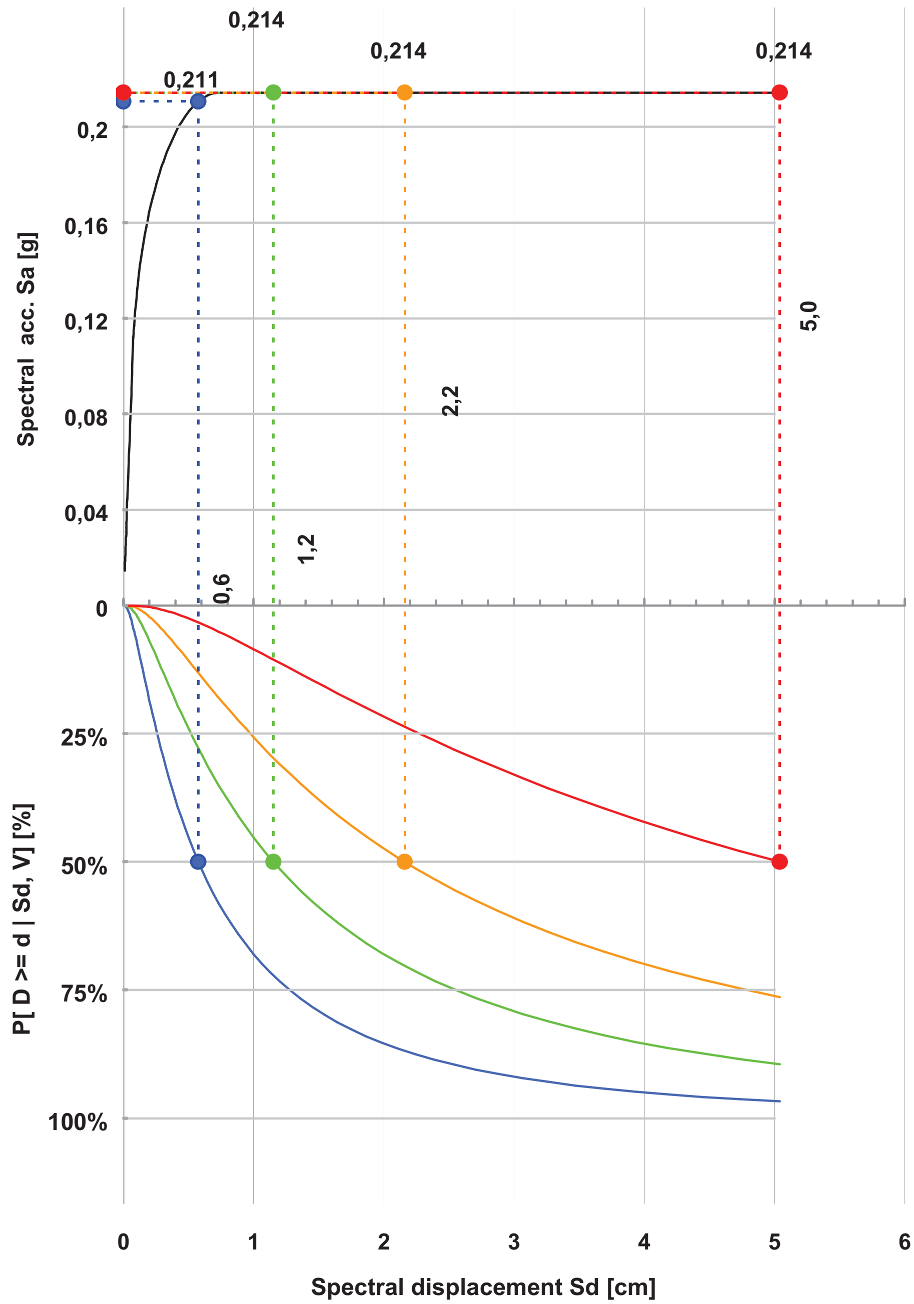
ANNEX A

Capacity and fragility curves, and median values of damage state

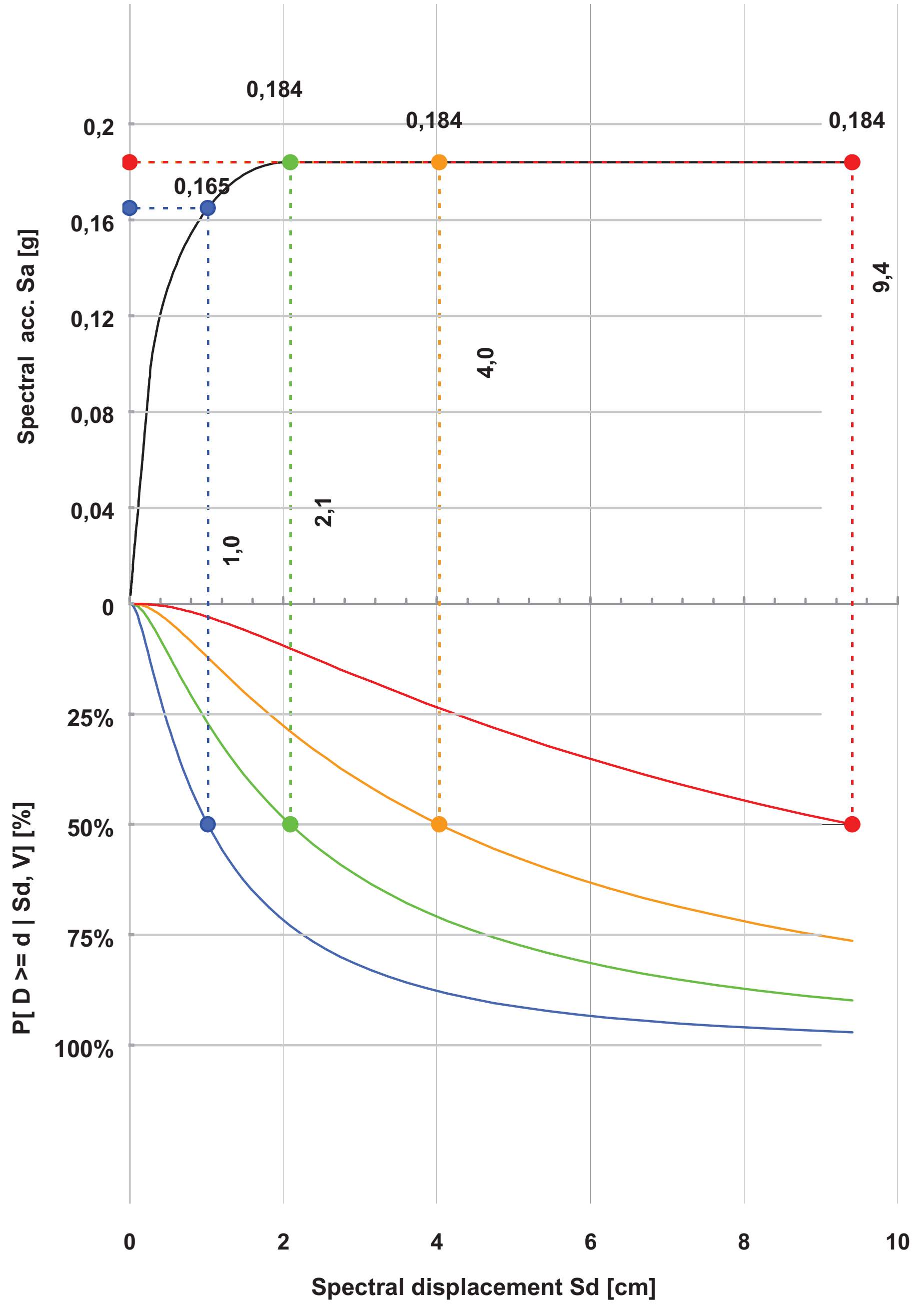
Adobe + ruble stone + Others; No. floors: 1

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,11	0,07	0,21	0,74	0,05	3,20	0,17	0,70	0,75	1,50	2,00	5,00
2	0,09	0,25	0,18	2,03	0,05	6,40	0,33	0,70	0,75	1,40	2,00	4,00
3	0,08	0,42	0,16	2,80	0,05	9,60	0,46	0,70	0,75	1,25	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



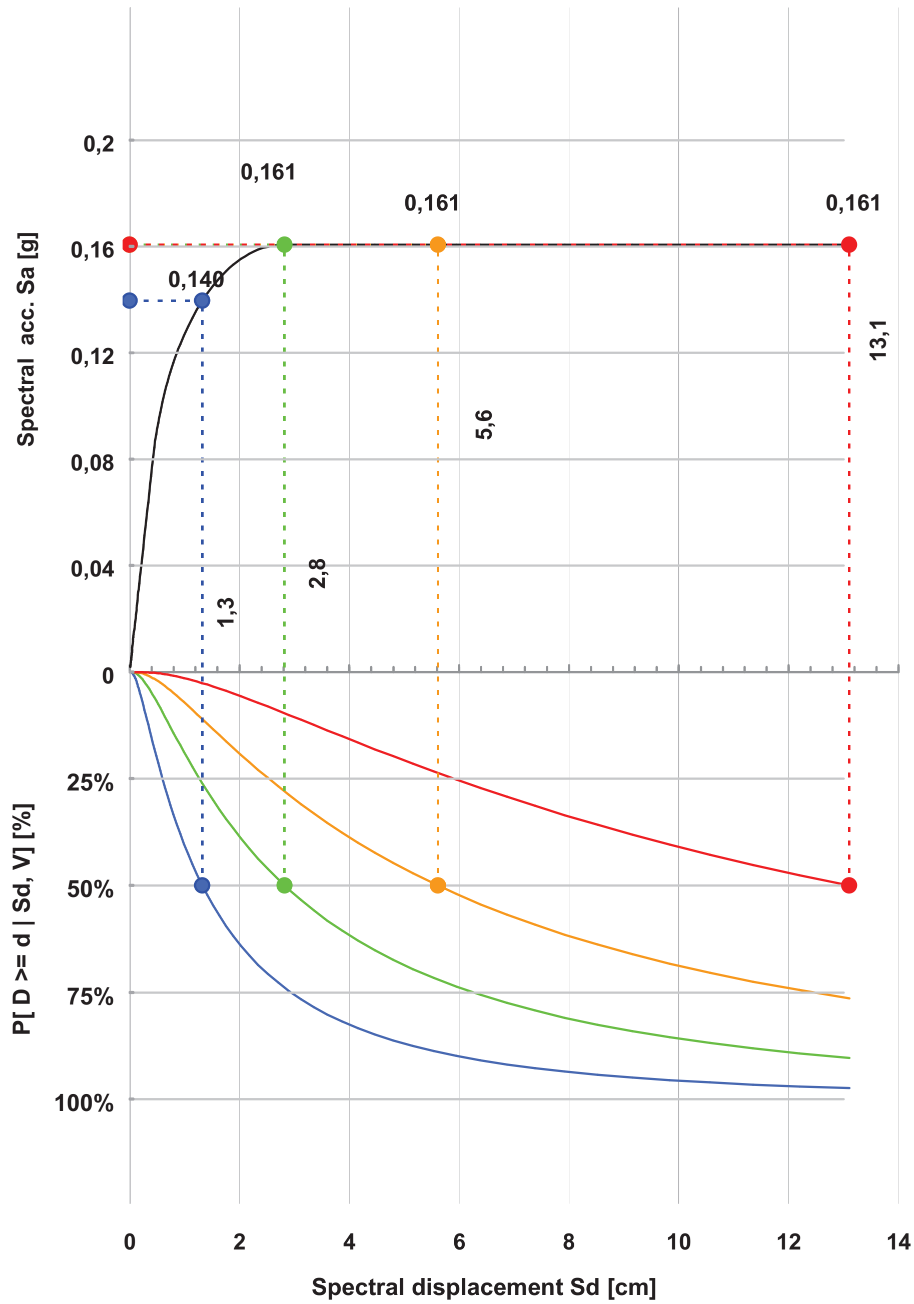
Adobe + ruble stone + Others; No. floors: 2

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,11	0,07	0,21	0,74	0,05	3,20	0,17	0,70	0,75	1,50	2,00	5,00
2	0,09	0,25	0,18	2,03	0,05	6,40	0,33	0,70	0,75	1,40	2,00	4,00
3	0,08	0,42	0,16	2,80	0,05	9,60	0,46	0,70	0,75	1,25	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



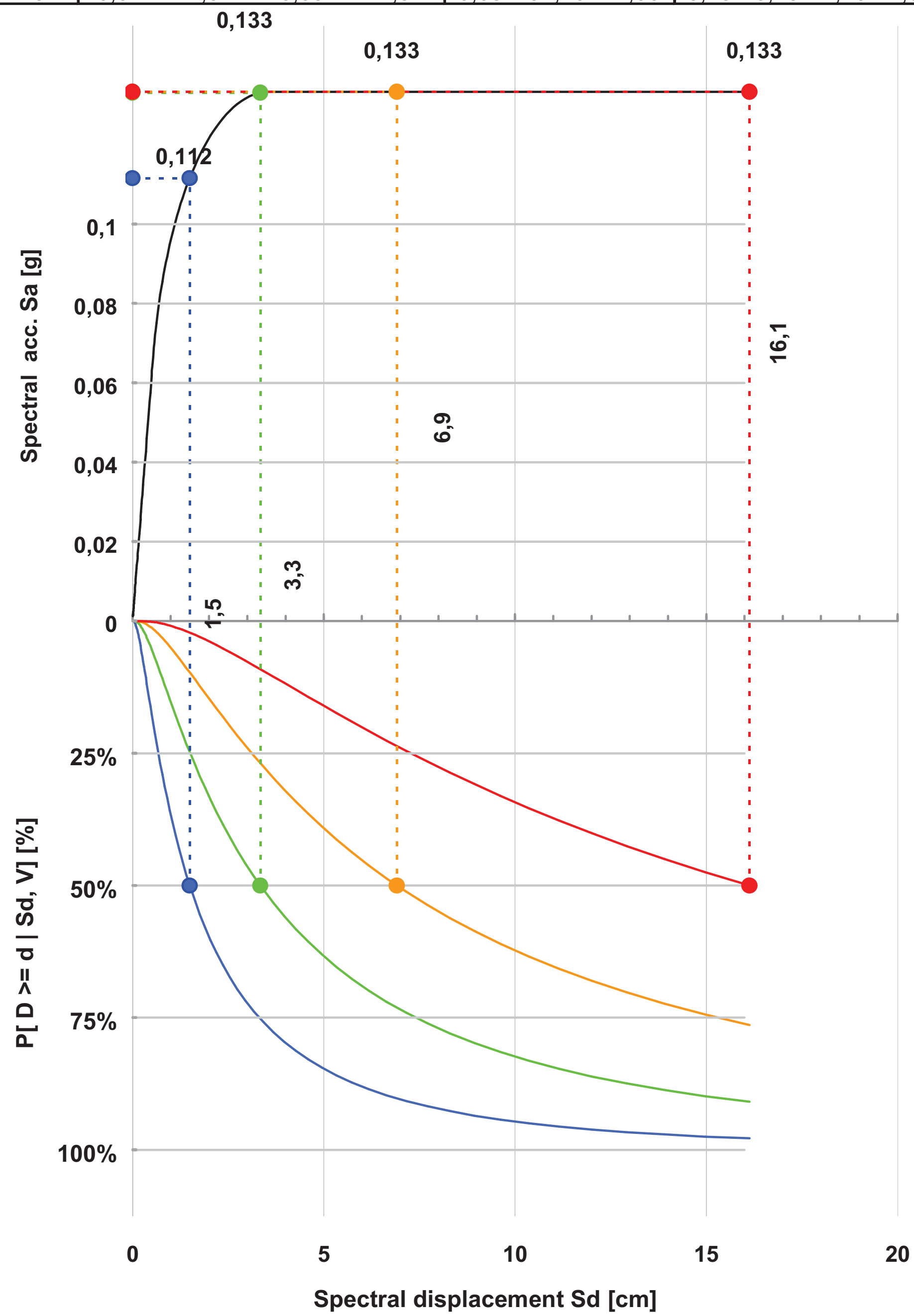
Adobe + ruble stone + Others; No. floors: 3

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,11	0,07	0,21	0,74	0,05	3,20	0,17	0,70	0,75	1,50	2,00	5,00
2	0,09	0,25	0,18	2,03	0,05	6,40	0,33	0,70	0,75	1,40	2,00	4,00
3	0,08	0,42	0,16	2,80	0,05	9,60	0,46	0,70	0,75	1,25	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



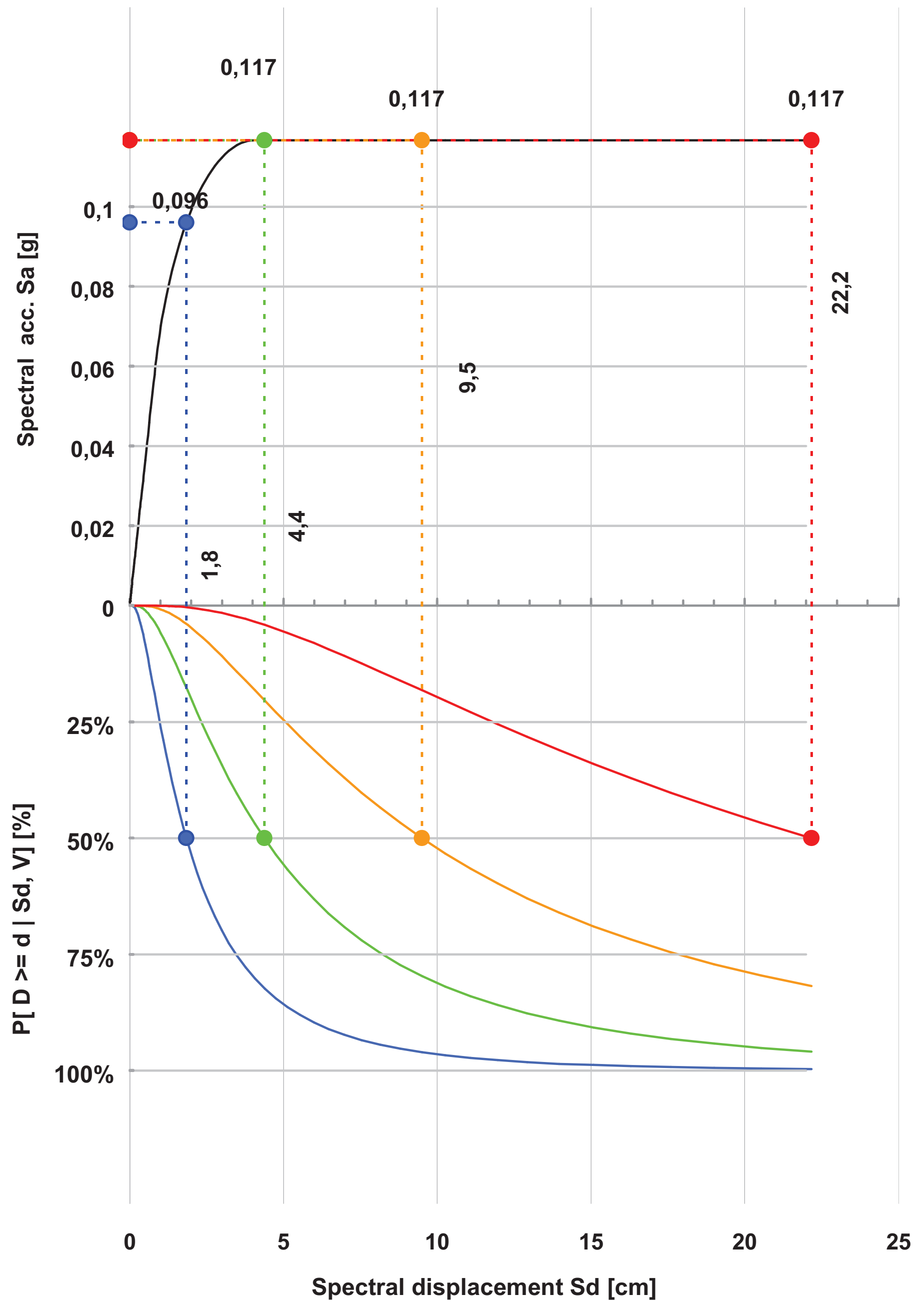
Adobe + ruble stone + Others; No. floors: 4

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,11	0,07	0,21	0,74	0,05	3,20	0,17	0,70	0,75	1,50	2,00	5,00
2	0,09	0,25	0,18	2,03	0,05	6,40	0,33	0,70	0,75	1,40	2,00	4,00
3	0,08	0,42	0,16	2,80	0,05	9,60	0,46	0,70	0,75	1,25	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



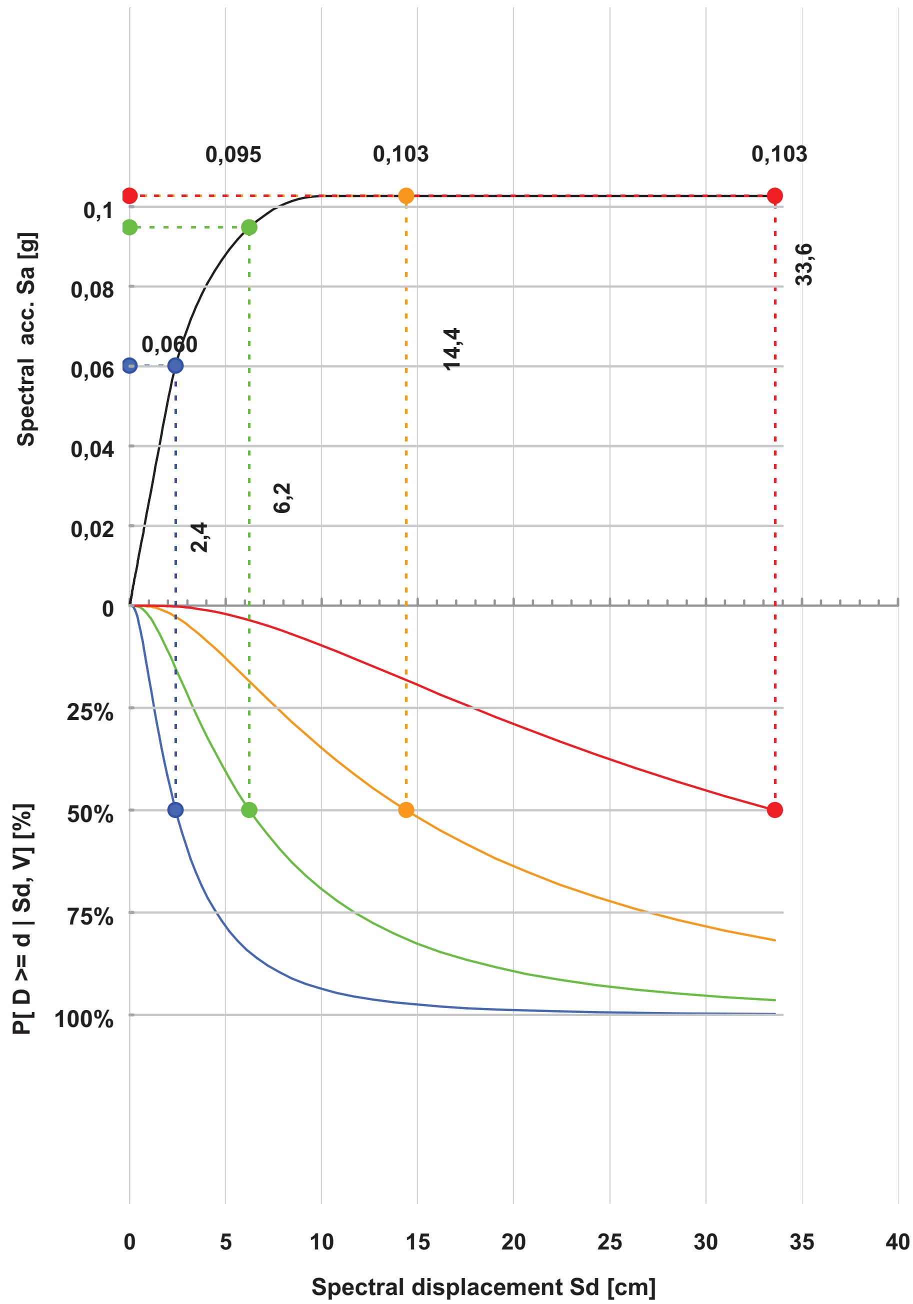
Adobe + ruble stone + Others; No. floors: 5-7

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,11	0,07	0,21	0,74	0,05	3,20	0,17	0,70	0,75	1,50	2,00	5,00
2	0,09	0,25	0,18	2,03	0,05	6,40	0,33	0,70	0,75	1,40	2,00	4,00
3	0,08	0,42	0,16	2,80	0,05	9,60	0,46	0,70	0,75	1,25	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



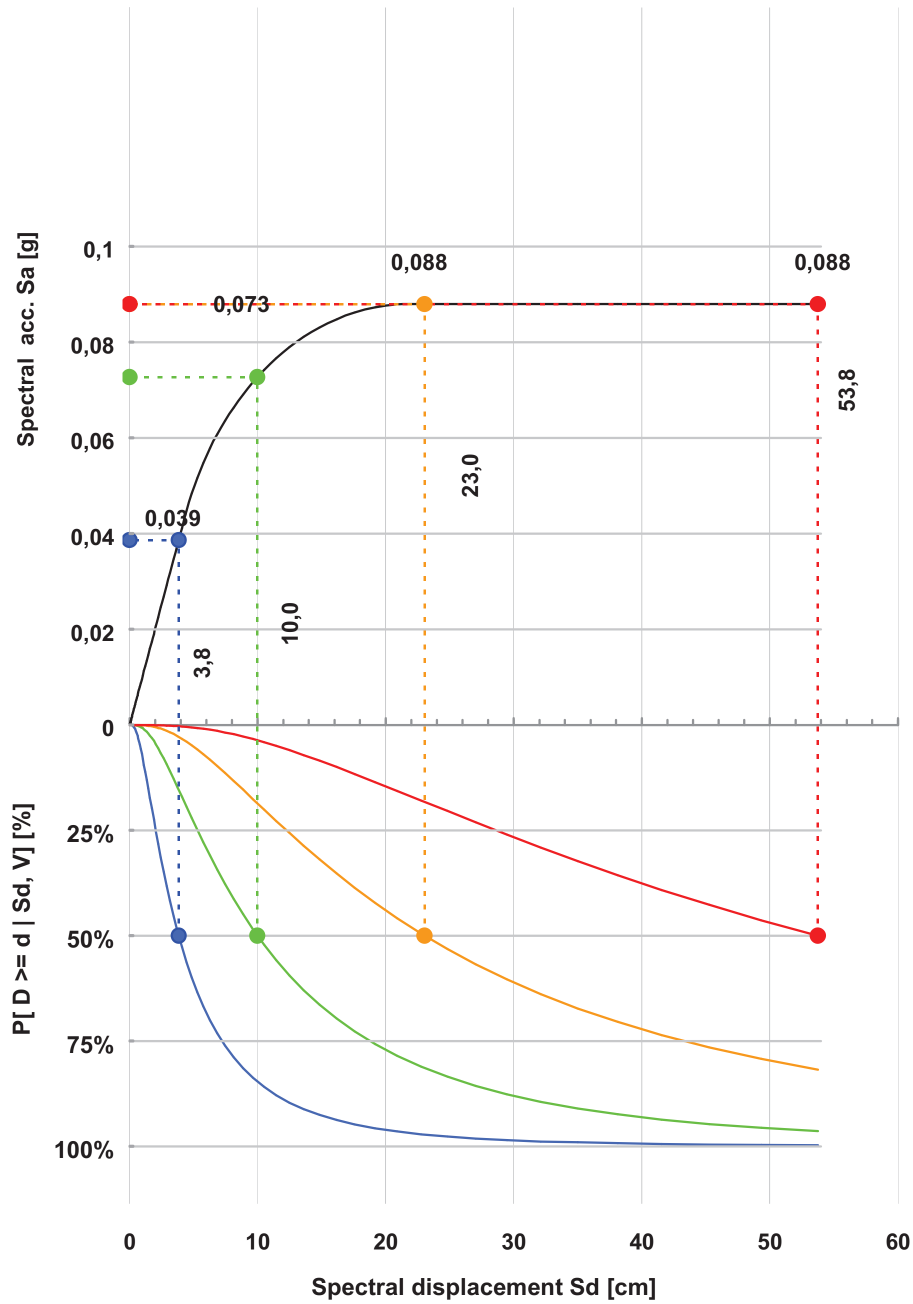
Adobe + ruble stone + Others; No. floors: 7-15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,11	0,07	0,21	0,74	0,05	3,20	0,17	0,70	0,75	1,50	2,00	5,00
2	0,09	0,25	0,18	2,03	0,05	6,40	0,33	0,70	0,75	1,40	2,00	4,00
3	0,08	0,42	0,16	2,80	0,05	9,60	0,46	0,70	0,75	1,25	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



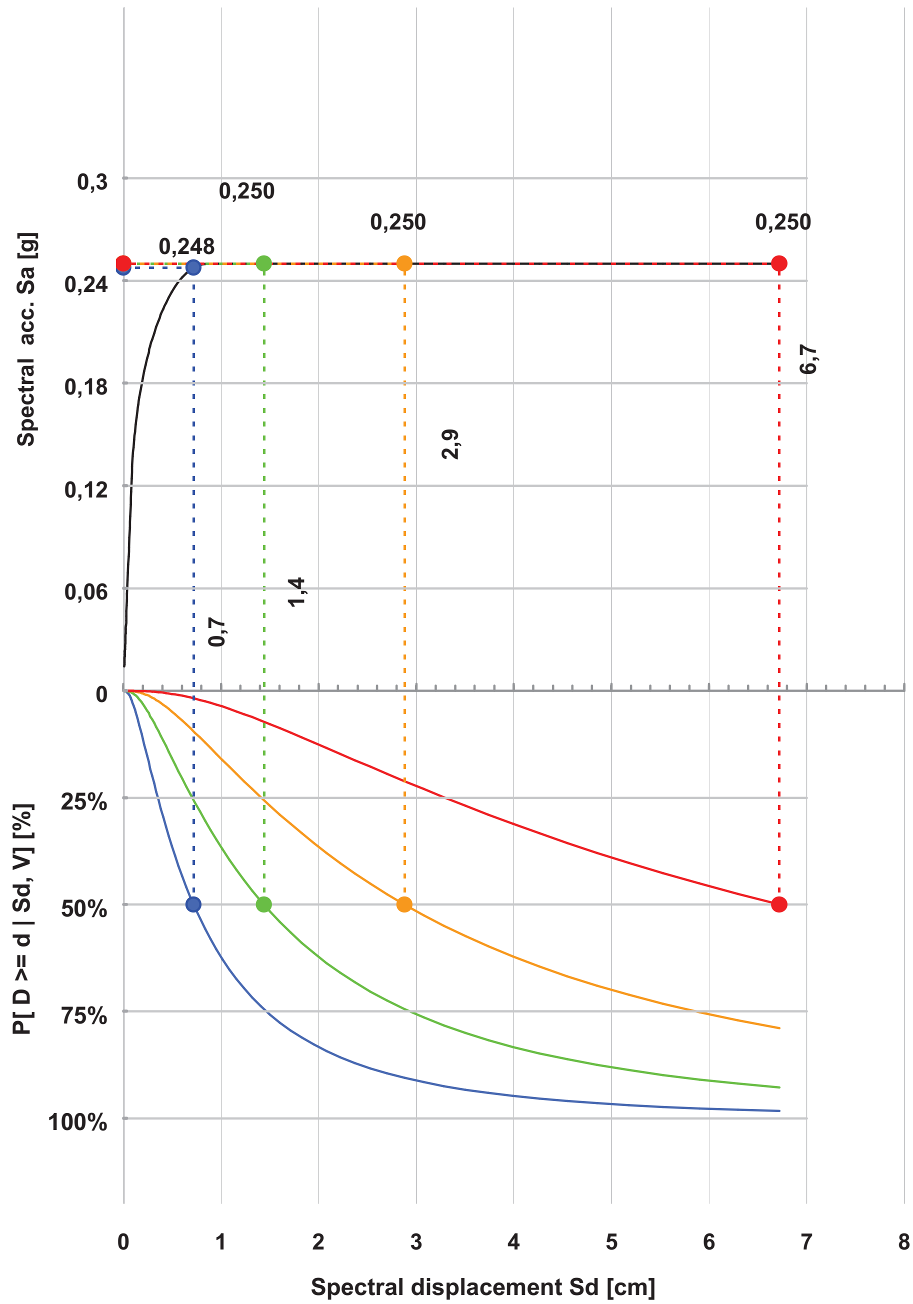
Adobe + ruble stone + Others; No. floors: >15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,11	0,07	0,21	0,74	0,05	3,20	0,17	0,70	0,75	1,50	2,00	5,00
2	0,09	0,25	0,18	2,03	0,05	6,40	0,33	0,70	0,75	1,40	2,00	4,00
3	0,08	0,42	0,16	2,80	0,05	9,60	0,46	0,70	0,75	1,25	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



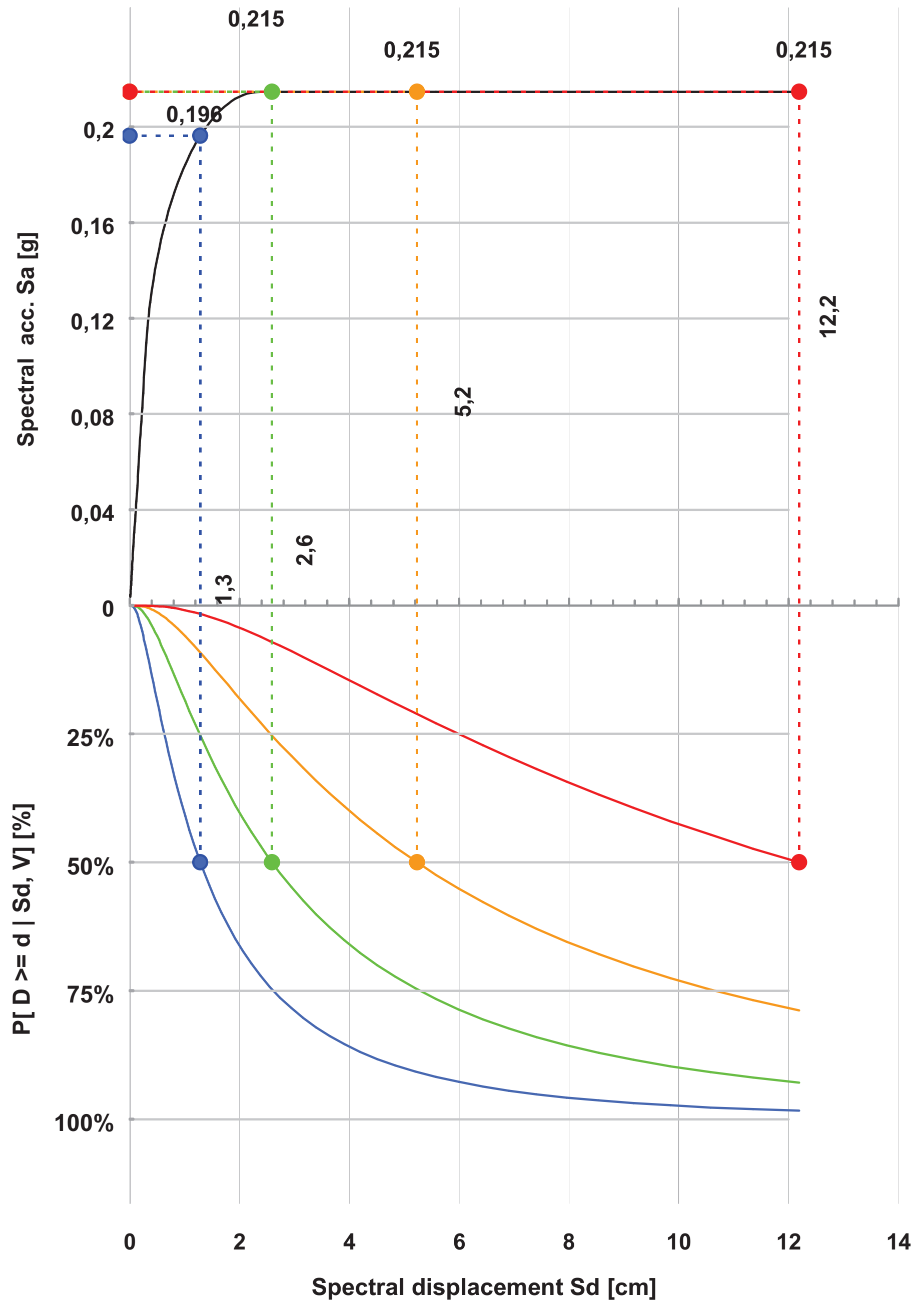
Masonry till 1960; No. floors: 1

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,13	0,09	0,25	0,86	0,05	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,11	0,30	0,21	2,37	0,05	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,09	0,45	0,17	2,98	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



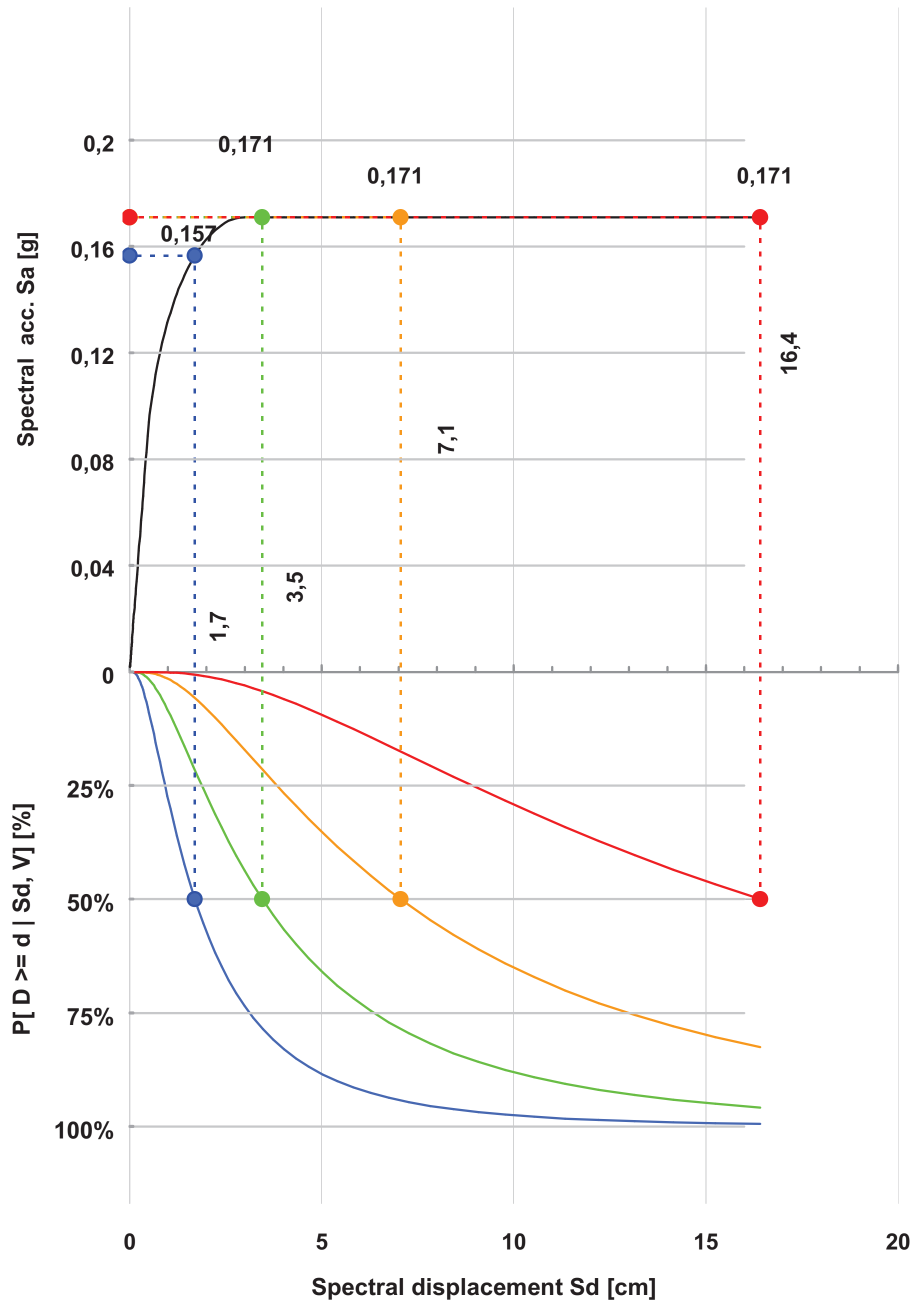
Masonry till 1960; No. floors: 2

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,13	0,09	0,25	0,86	0,05	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,11	0,30	0,21	2,37	0,05	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,09	0,45	0,17	2,98	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



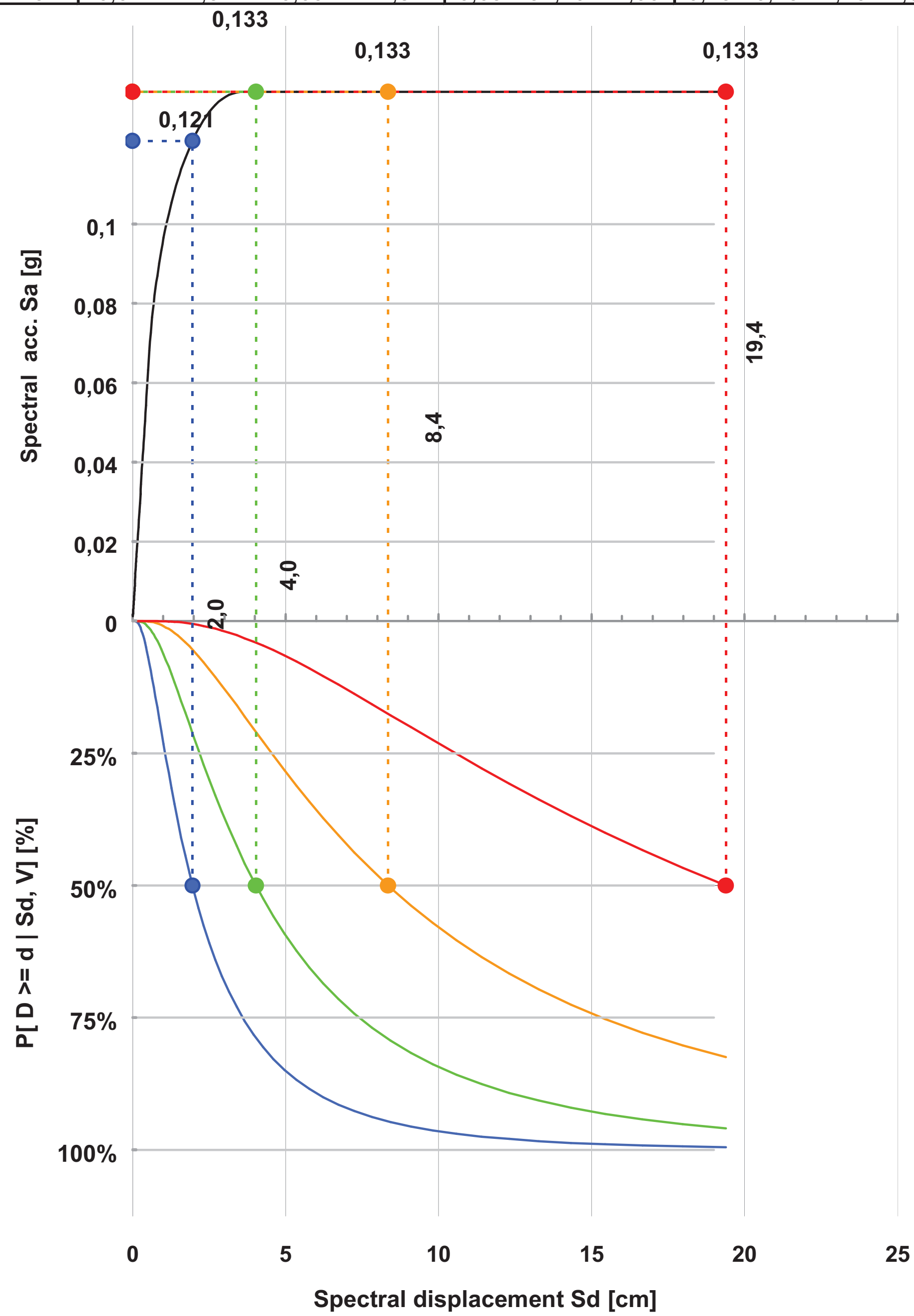
Masonry till 1960; No. floors: 3

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,13	0,09	0,25	0,86	0,05	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,11	0,30	0,21	2,37	0,05	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,09	0,45	0,17	2,98	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



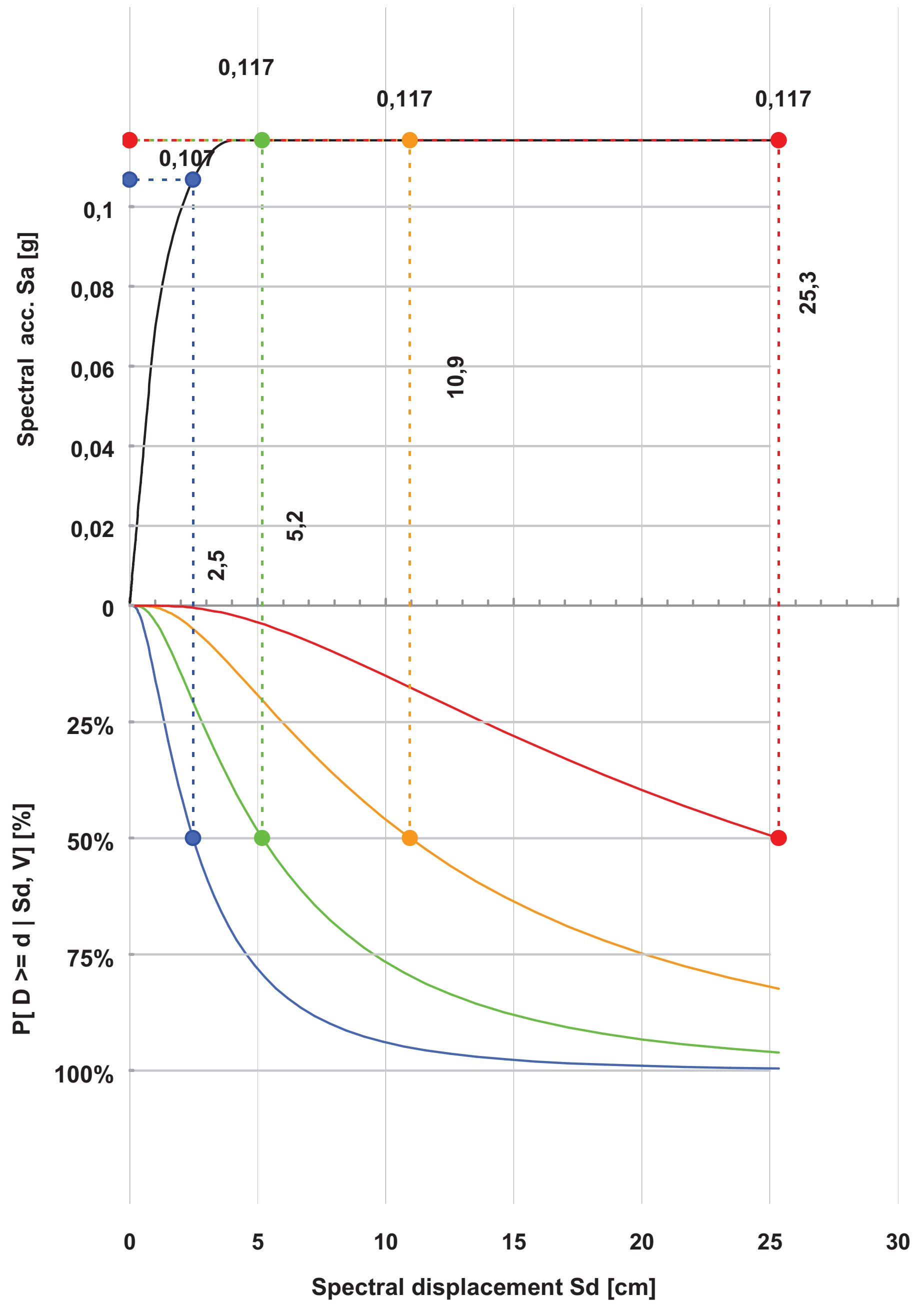
Masonry till 1960; No. floors: 4

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,13	0,09	0,25	0,86	0,05	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,11	0,30	0,21	2,37	0,05	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,09	0,45	0,17	2,98	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



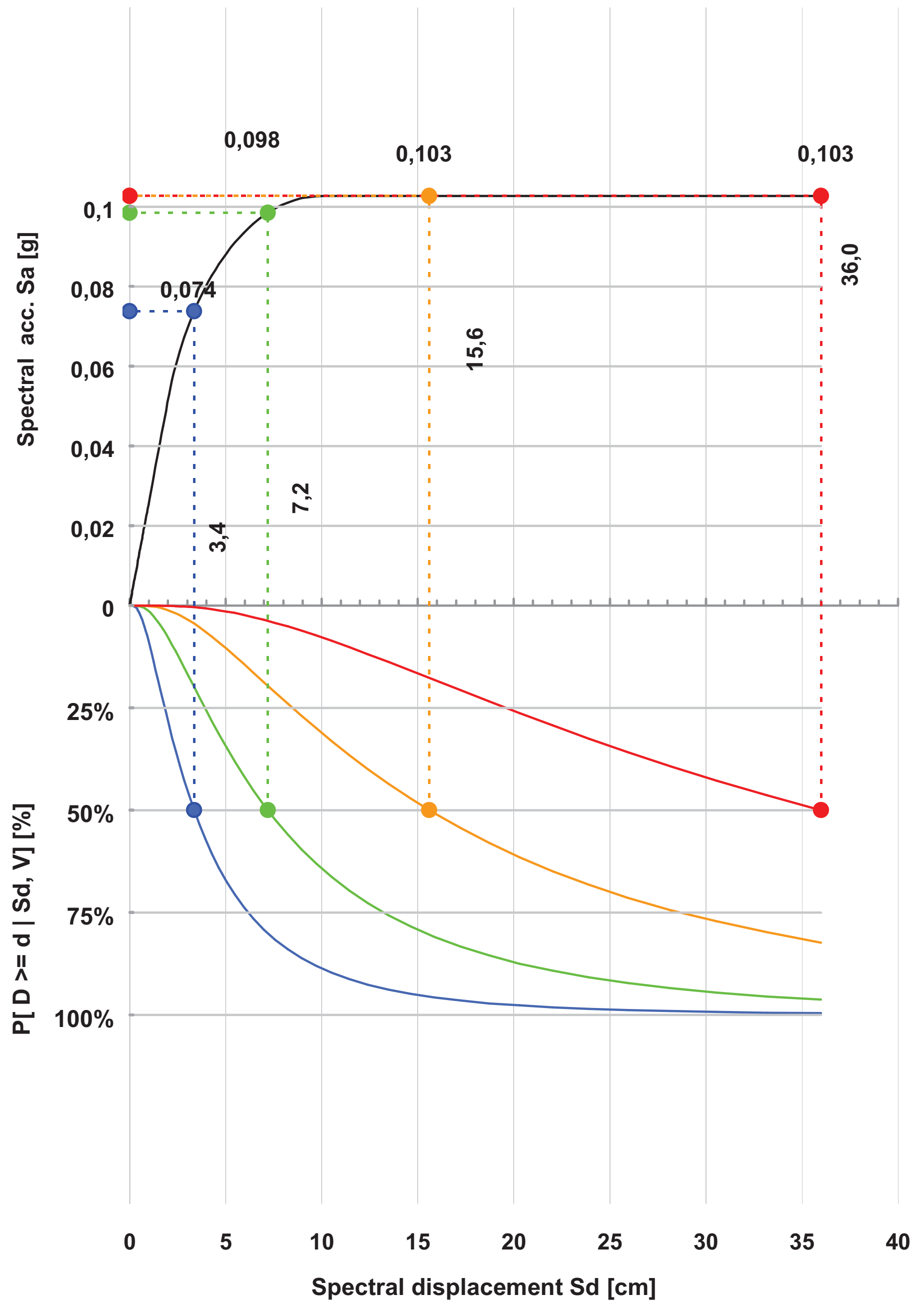
Masonry till 1960; No. floors: 5-7

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,13	0,09	0,25	0,86	0,05	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,11	0,30	0,21	2,37	0,05	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,09	0,45	0,17	2,98	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



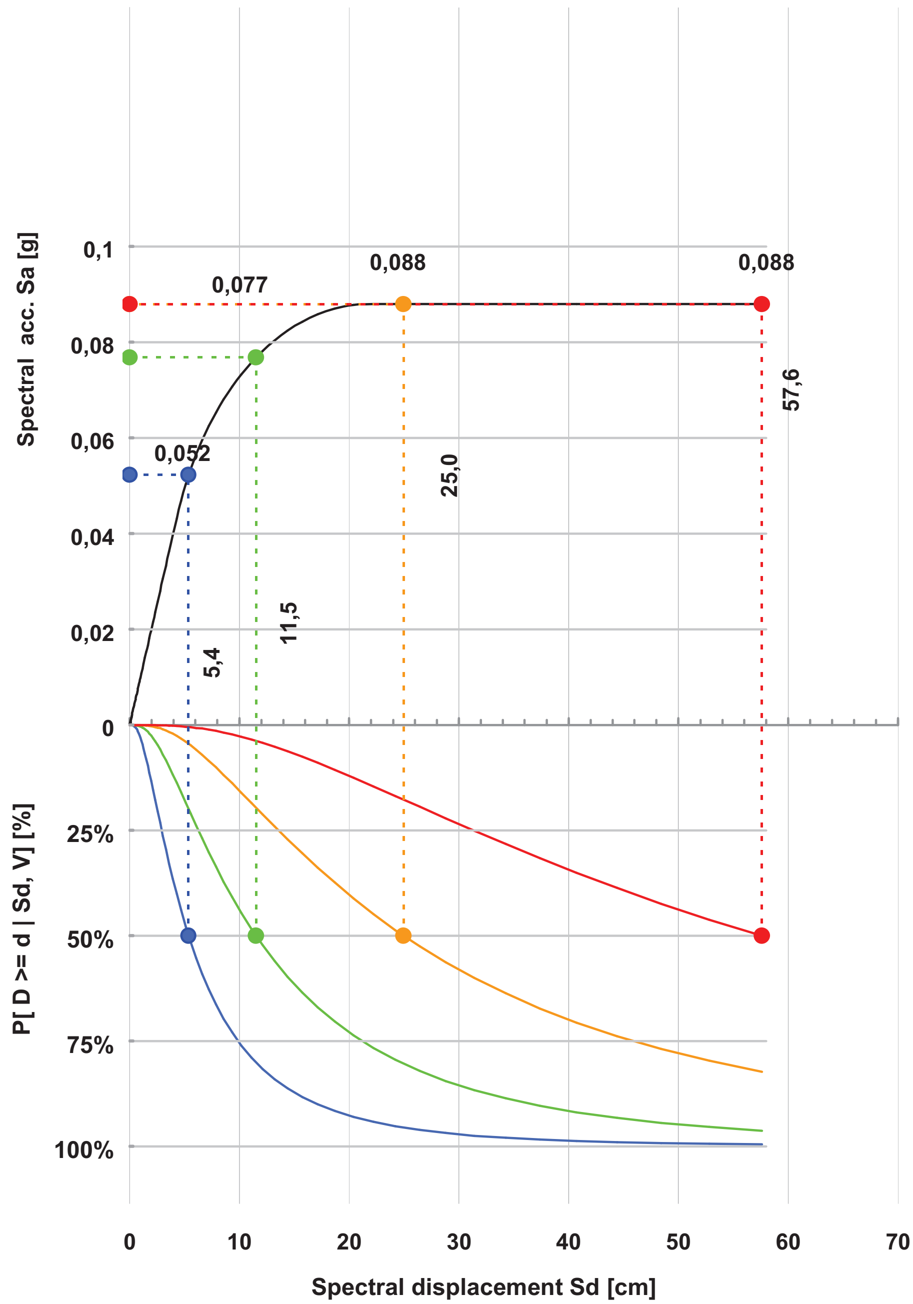
Masonry till 1960; No. floors: 7-15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,13	0,09	0,25	0,86	0,05	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,11	0,30	0,21	2,37	0,05	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,09	0,45	0,17	2,98	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



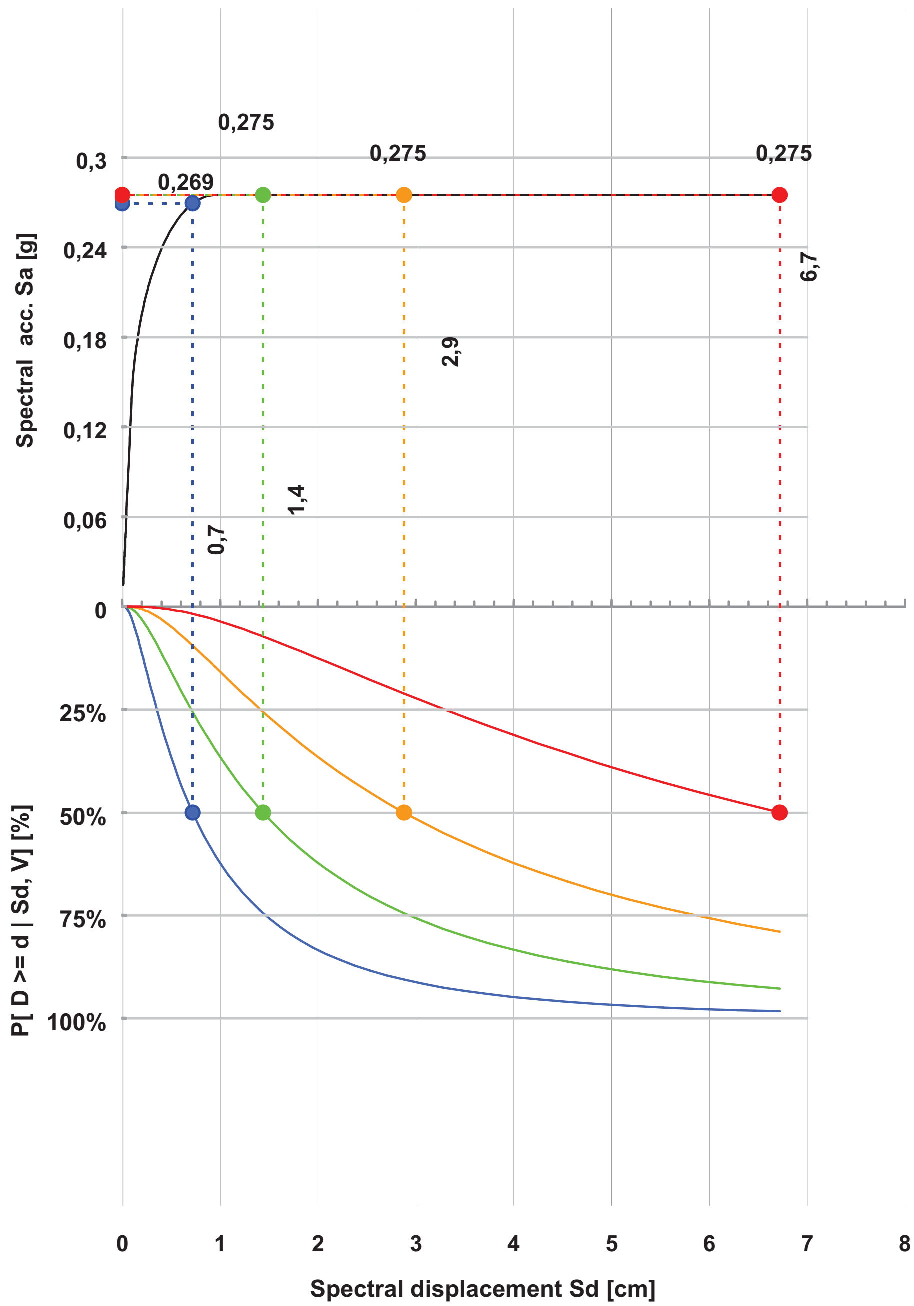
Masonry till 1960; No. floors: >15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,13	0,09	0,25	0,86	0,05	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,11	0,30	0,21	2,37	0,05	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,09	0,45	0,17	2,98	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,07	0,54	0,13	3,57	0,04	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,06	0,81	0,12	4,07	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,05	1,99	0,10	9,96	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,04	4,37	0,09	21,84	0,03	51,20	2,00	0,75	0,75	1,10	2,00	2,50



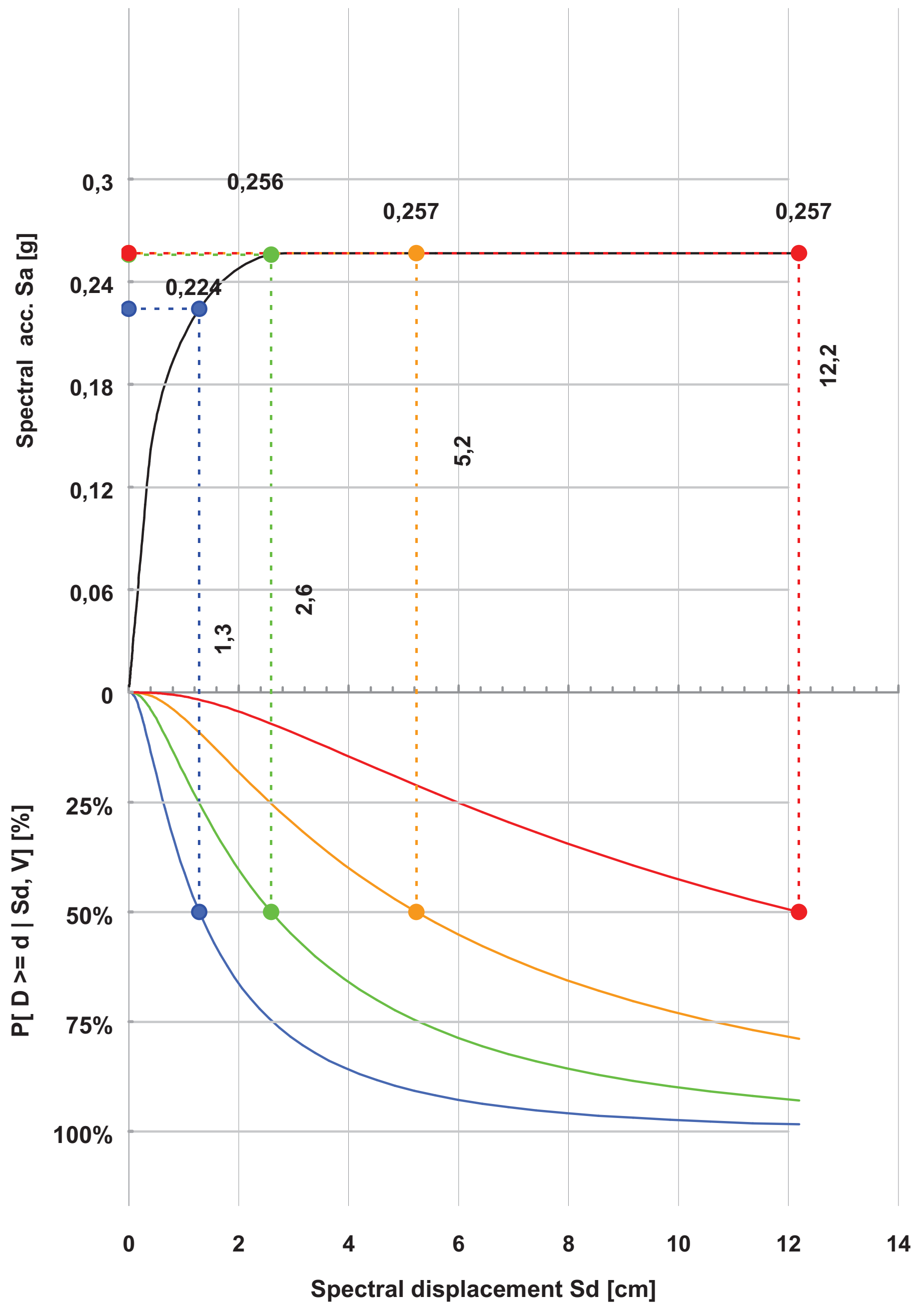
Masonry 1961-85; No. floors: 1

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,14	0,09	0,28	0,95	0,06	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,13	0,35	0,26	2,83	0,06	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,10	0,50	0,19	3,32	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,08	0,68	0,17	4,46	0,05	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,07	0,93	0,13	4,65	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,06	2,28	0,12	11,38	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,06	5,83	0,12	29,13	0,04	51,20	2,00	0,75	0,75	1,10	2,00	2,50



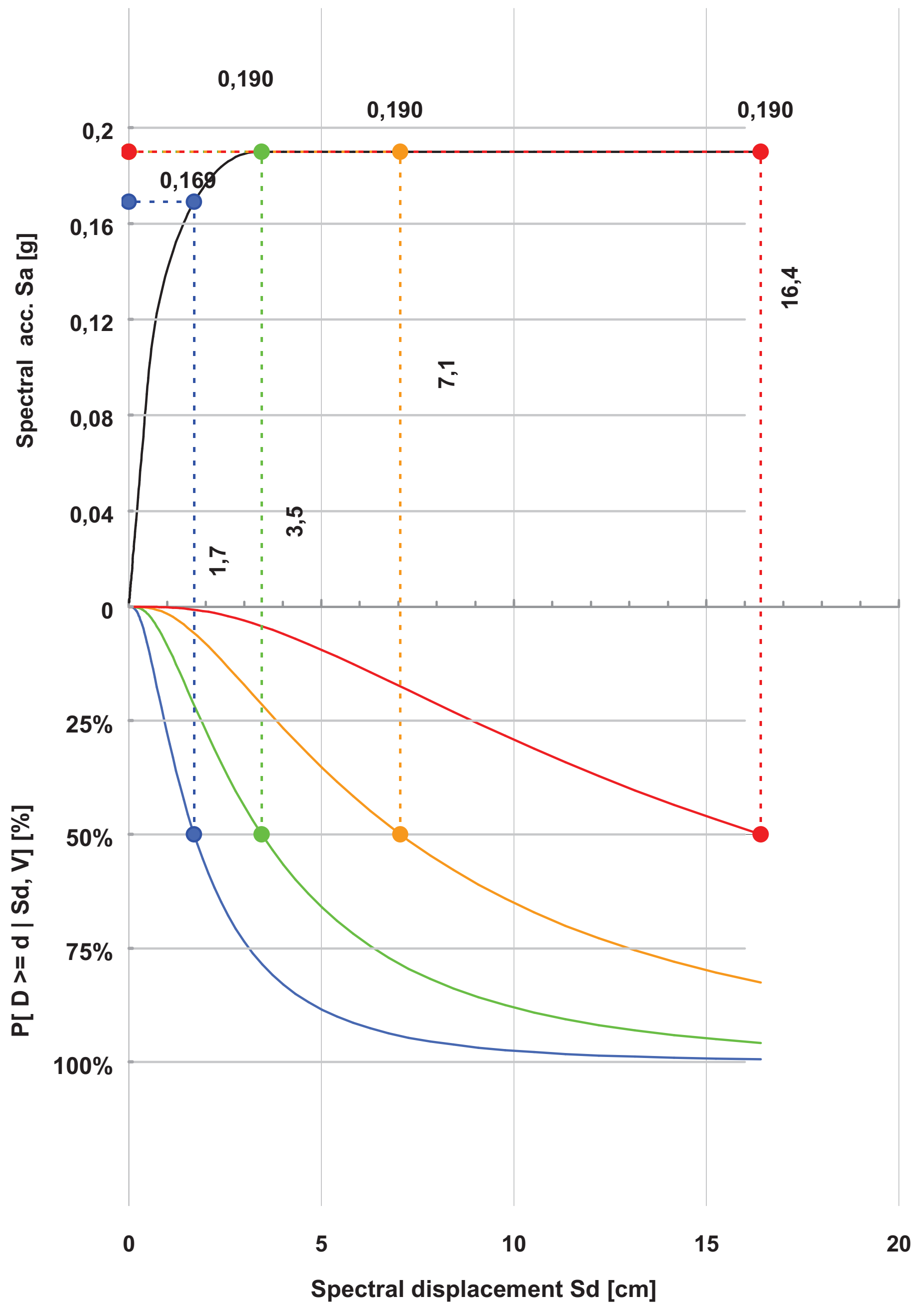
Masonry 1961-85; No. floors: 2

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,14	0,09	0,28	0,95	0,06	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,13	0,35	0,26	2,83	0,06	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,10	0,50	0,19	3,32	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,08	0,68	0,17	4,46	0,05	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,07	0,93	0,13	4,65	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,06	2,28	0,12	11,38	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,06	5,83	0,12	29,13	0,04	51,20	2,00	0,75	0,75	1,10	2,00	2,50



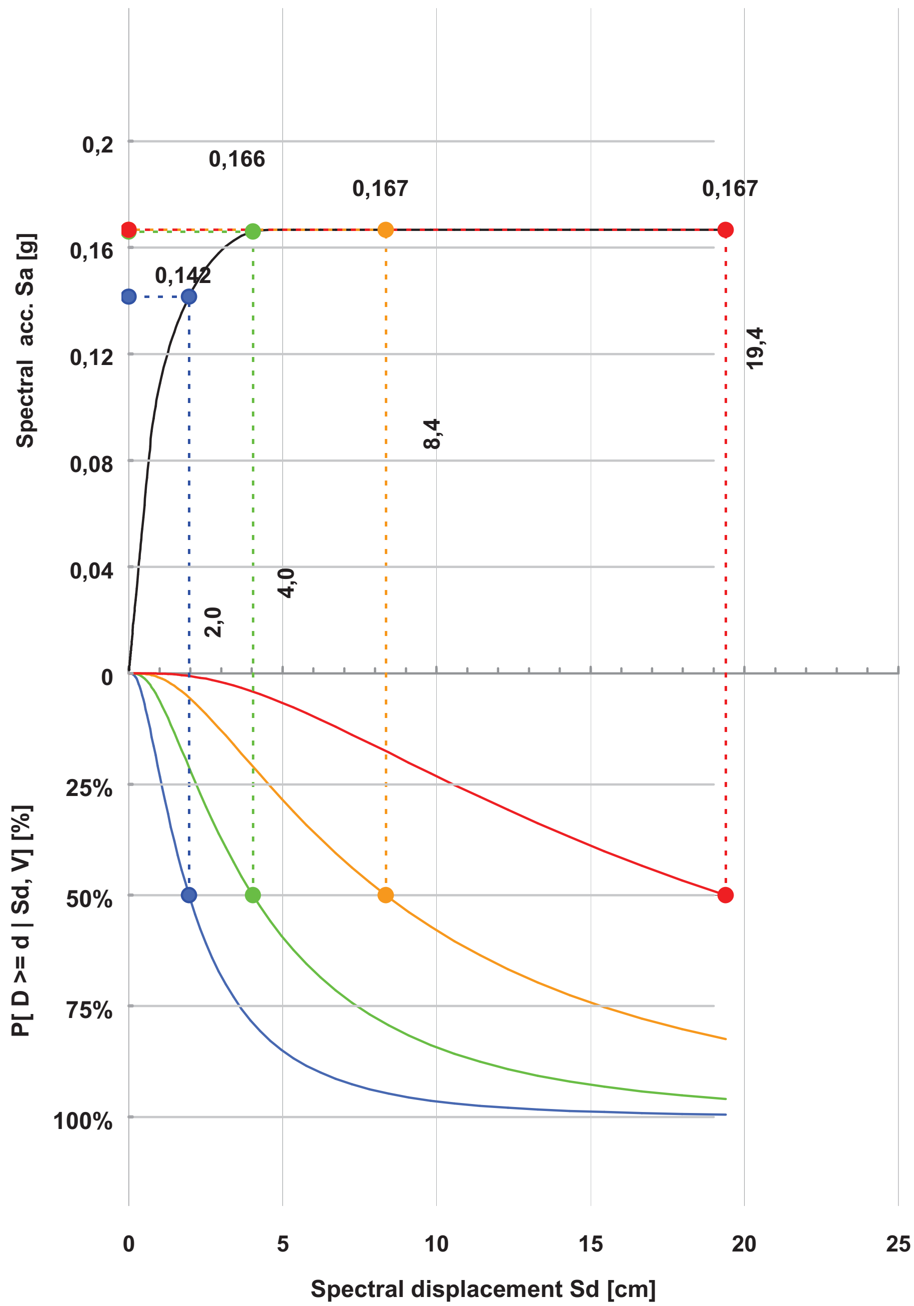
Masonry 1961-85; No. floors: 3

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,14	0,09	0,28	0,95	0,06	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,13	0,35	0,26	2,83	0,06	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,10	0,50	0,19	3,32	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,08	0,68	0,17	4,46	0,05	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,07	0,93	0,13	4,65	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,06	2,28	0,12	11,38	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,06	5,83	0,12	29,13	0,04	51,20	2,00	0,75	0,75	1,10	2,00	2,50



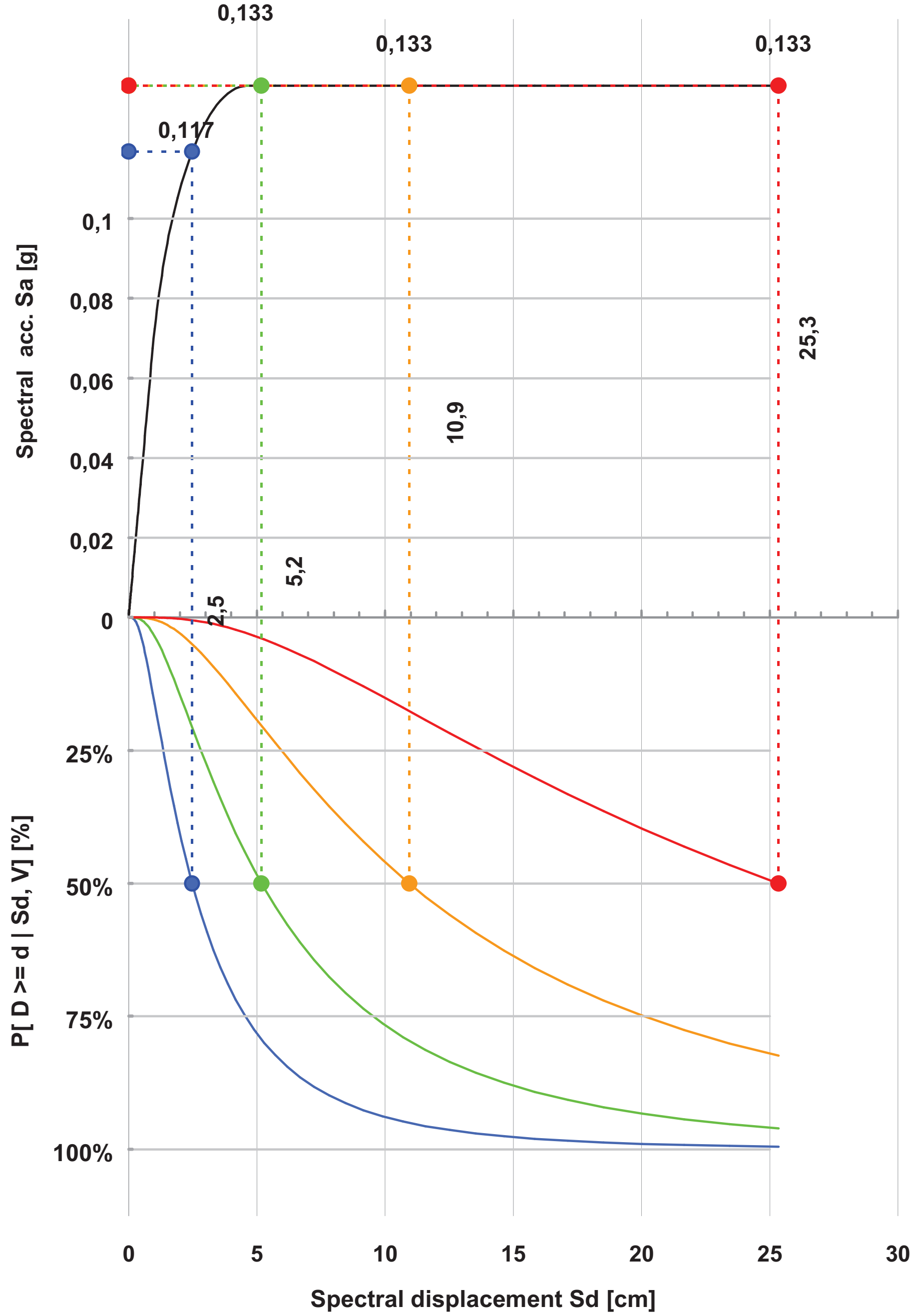
Masonry 1961-85; No. floors: 4

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,14	0,09	0,28	0,95	0,06	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,13	0,35	0,26	2,83	0,06	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,10	0,50	0,19	3,32	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,08	0,68	0,17	4,46	0,05	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,07	0,93	0,13	4,65	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,06	2,28	0,12	11,38	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,06	5,83	0,12	29,13	0,04	51,20	2,00	0,75	0,75	1,10	2,00	2,50



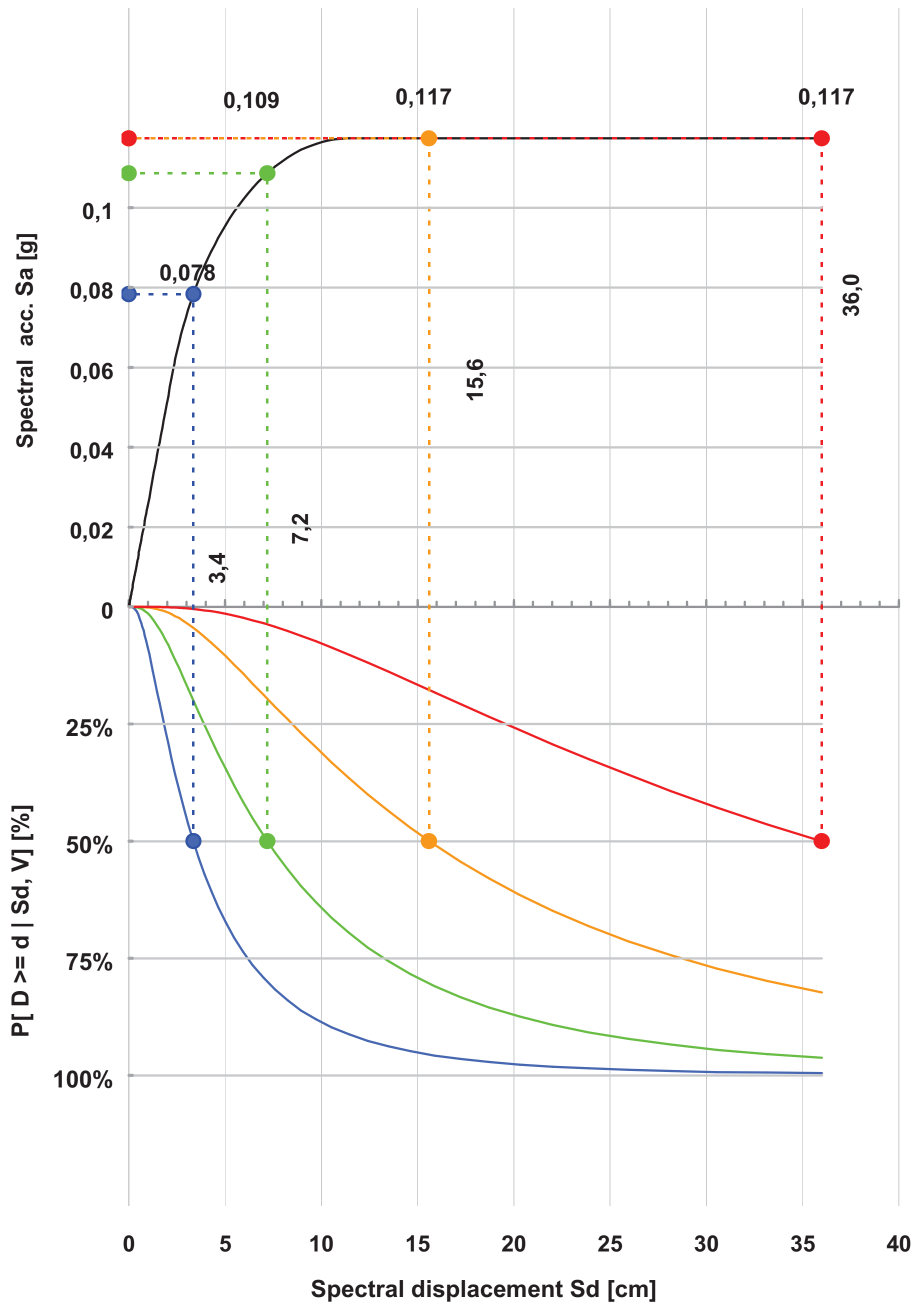
Masonry 1961-85; No. floors: 5-7

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,14	0,09	0,28	0,95	0,06	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,13	0,35	0,26	2,83	0,06	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,10	0,50	0,19	3,32	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,08	0,68	0,17	4,46	0,05	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,07	0,93	0,13	4,65	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,06	2,28	0,12	11,38	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,06	5,83	0,12	29,13	0,04	51,20	2,00	0,75	0,75	1,10	2,00	2,50



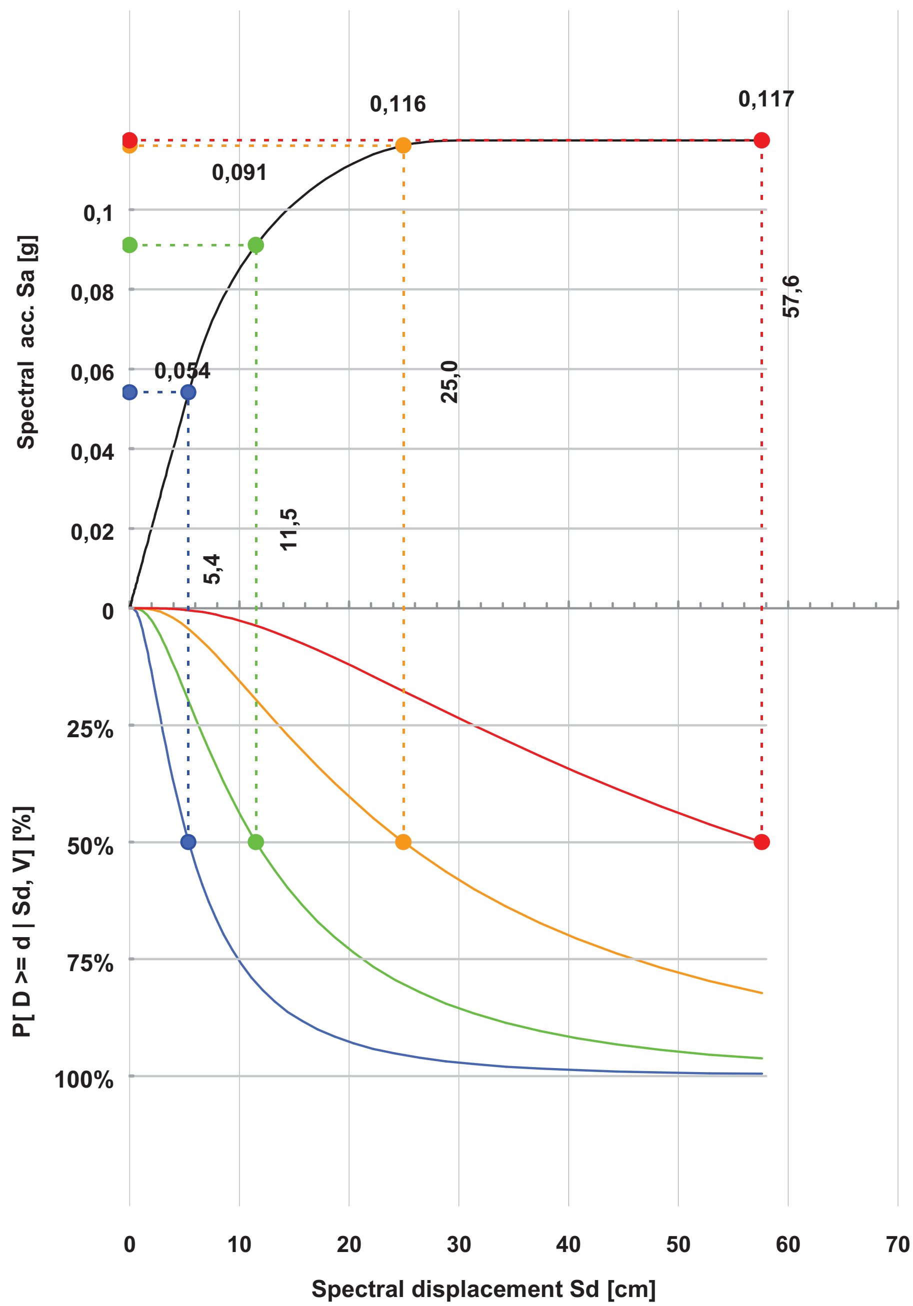
Masonry 1961-85; No. floors: 7-15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,14	0,09	0,28	0,95	0,06	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,13	0,35	0,26	2,83	0,06	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,10	0,50	0,19	3,32	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,08	0,68	0,17	4,46	0,05	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,07	0,93	0,13	4,65	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,06	2,28	0,12	11,38	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,06	5,83	0,12	29,13	0,04	51,20	2,00	0,75	0,75	1,10	2,00	2,50



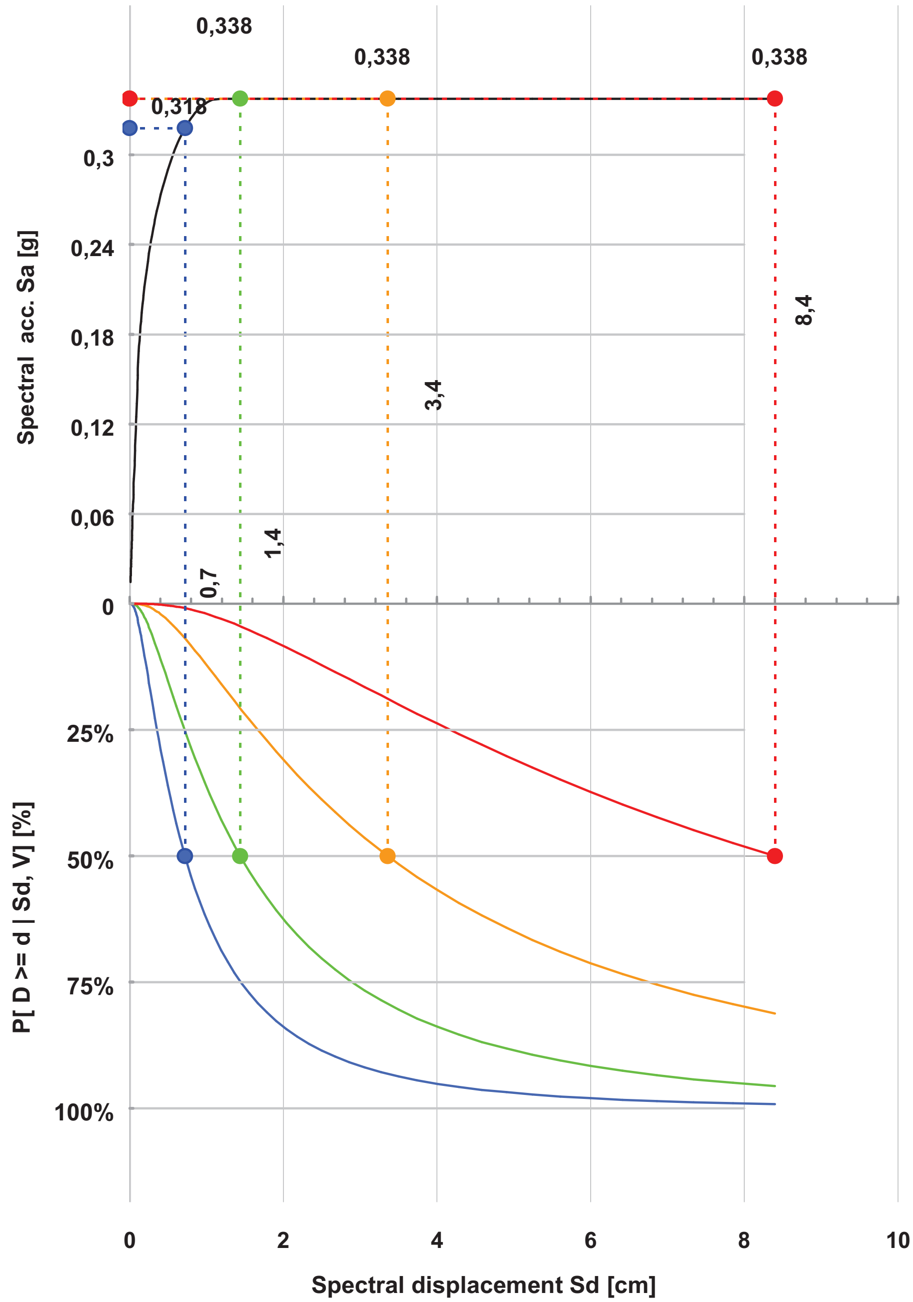
Masonry 1961-85; No. floors: >15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,14	0,09	0,28	0,95	0,06	3,20	0,17	0,60	0,75	1,50	2,00	5,00
2	0,13	0,35	0,26	2,83	0,06	6,40	0,33	0,60	0,75	1,40	2,00	4,00
3	0,10	0,50	0,19	3,32	0,05	9,60	0,46	0,70	0,75	1,33	2,00	3,30
4	0,08	0,68	0,17	4,46	0,05	12,80	0,57	0,75	0,75	1,25	2,00	3,30
5-7	0,07	0,93	0,13	4,65	0,04	19,20	0,75	0,75	0,75	1,25	2,00	2,50
7-15	0,06	2,28	0,12	11,38	0,04	32,00	1,25	0,75	0,75	1,10	2,00	2,50
>15	0,06	5,83	0,12	29,13	0,04	51,20	2,00	0,75	0,75	1,10	2,00	2,50



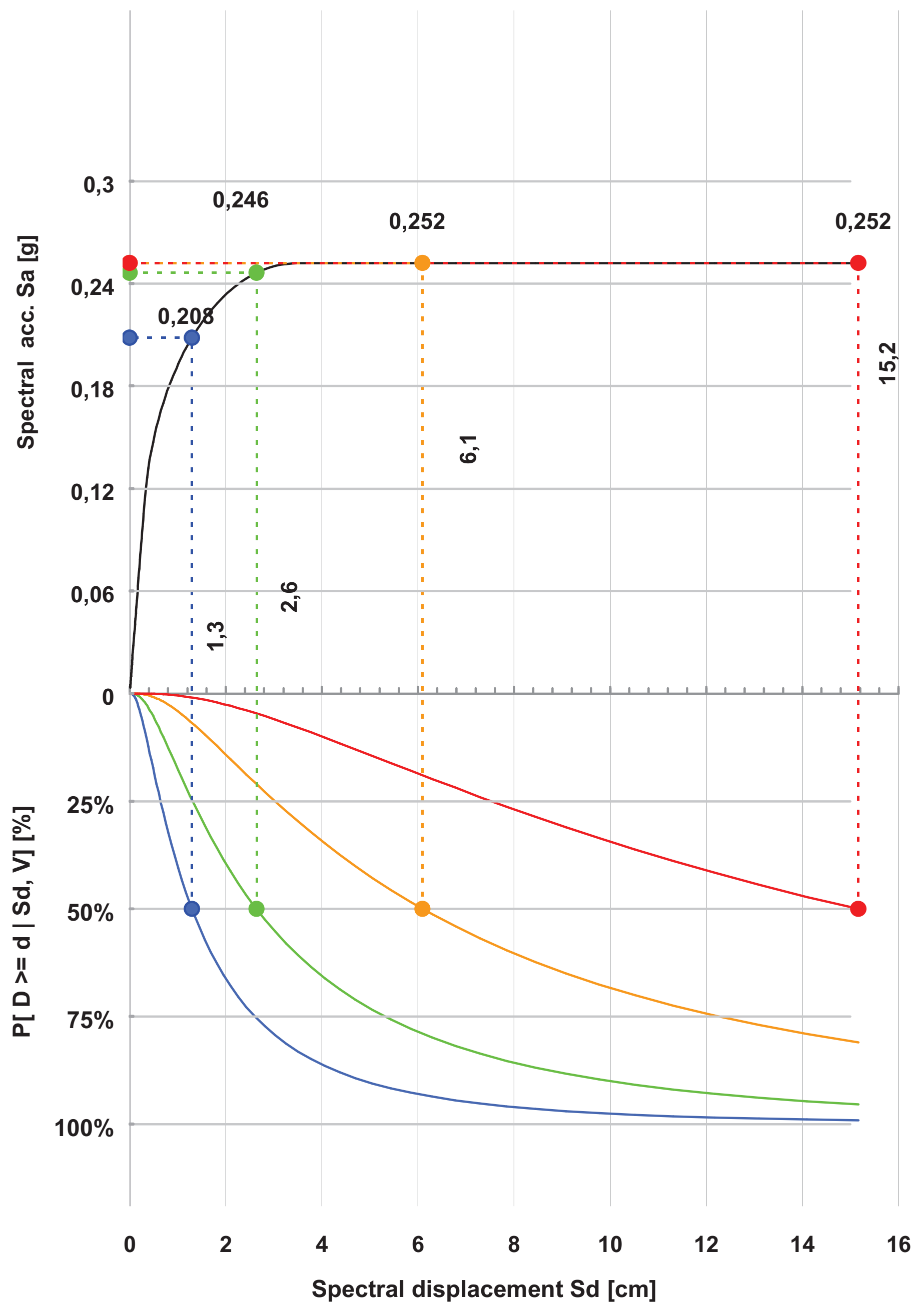
Masonry 1986-01; No. floors: 1

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,15	0,10	0,34	1,16	0,08	3,20	0,17	0,75	0,75	1,50	2,25	5,00
2	0,11	0,31	0,25	3,48	0,06	6,40	0,33	0,75	0,75	1,40	2,25	5,00
3	0,09	0,47	0,20	4,22	0,05	9,60	0,46	0,75	0,75	1,33	2,25	4,00
4	0,08	0,68	0,19	5,02	0,05	12,80	0,57	0,75	0,75	1,25	2,25	3,30
5-7	0,07	0,93	0,15	6,91	0,04	19,20	0,75	0,75	0,75	1,25	2,25	3,30
7-15	0,06	2,49	0,14	14,03	0,04	32,00	1,25	0,65	0,75	1,10	2,25	2,50
>15	0,06	6,39	0,14	35,92	0,04	51,20	2,00	0,65	0,75	1,10	2,25	2,50



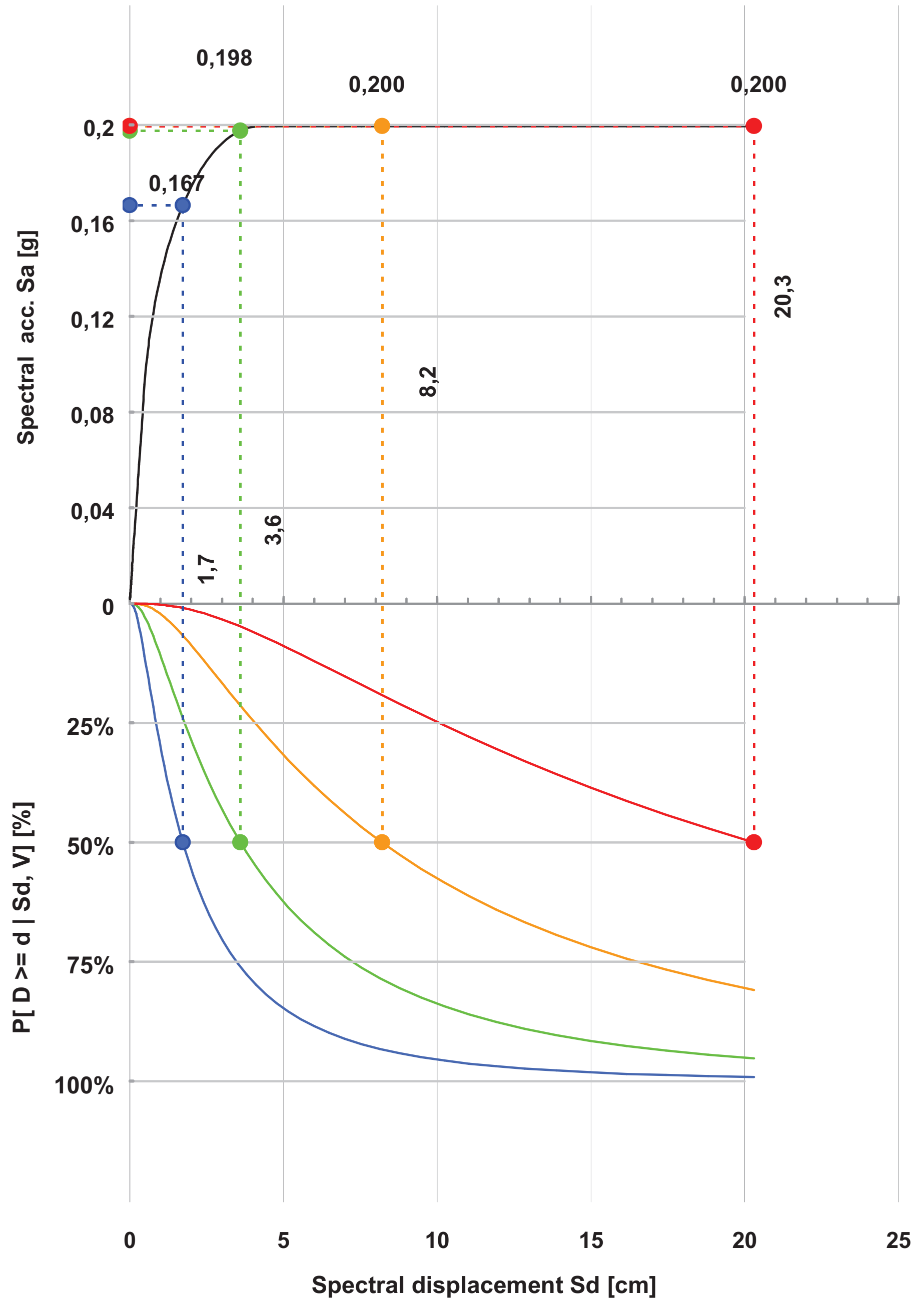
Masonry 1986-01; No. floors: 2

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,15	0,10	0,34	1,16	0,08	3,20	0,17	0,75	0,75	1,50	2,25	5,00
2	0,11	0,31	0,25	3,48	0,06	6,40	0,33	0,75	0,75	1,40	2,25	5,00
3	0,09	0,47	0,20	4,22	0,05	9,60	0,46	0,75	0,75	1,33	2,25	4,00
4	0,08	0,68	0,19	5,02	0,05	12,80	0,57	0,75	0,75	1,25	2,25	3,30
5-7	0,07	0,93	0,15	6,91	0,04	19,20	0,75	0,75	0,75	1,25	2,25	3,30
7-15	0,06	2,49	0,14	14,03	0,04	32,00	1,25	0,65	0,75	1,10	2,25	2,50
>15	0,06	6,39	0,14	35,92	0,04	51,20	2,00	0,65	0,75	1,10	2,25	2,50



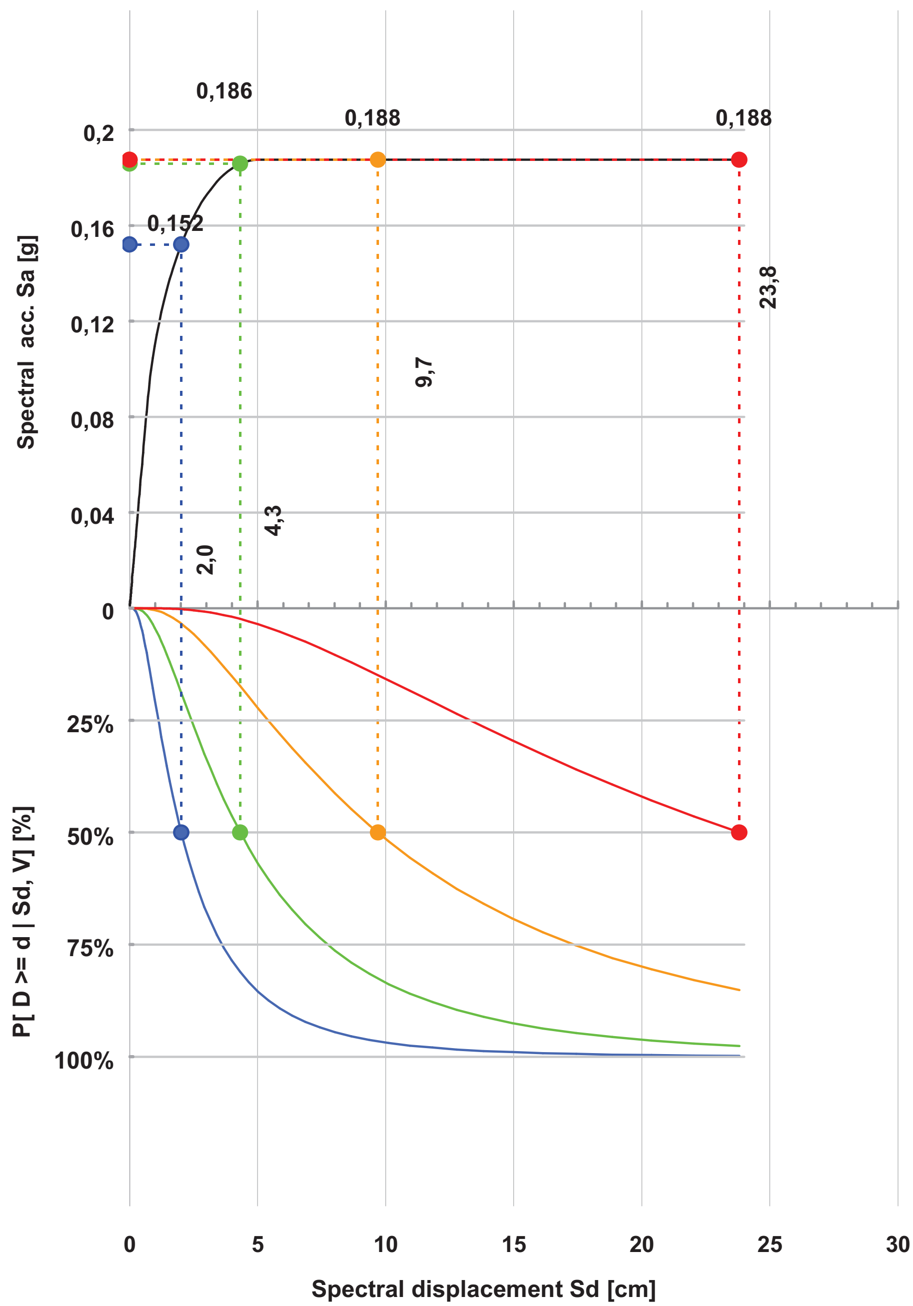
Masonry 1986-01; No. floors: 3

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,15	0,10	0,34	1,16	0,08	3,20	0,17	0,75	0,75	1,50	2,25	5,00
2	0,11	0,31	0,25	3,48	0,06	6,40	0,33	0,75	0,75	1,40	2,25	5,00
3	0,09	0,47	0,20	4,22	0,05	9,60	0,46	0,75	0,75	1,33	2,25	4,00
4	0,08	0,68	0,19	5,02	0,05	12,80	0,57	0,75	0,75	1,25	2,25	3,30
5-7	0,07	0,93	0,15	6,91	0,04	19,20	0,75	0,75	0,75	1,25	2,25	3,30
7-15	0,06	2,49	0,14	14,03	0,04	32,00	1,25	0,65	0,75	1,10	2,25	2,50
>15	0,06	6,39	0,14	35,92	0,04	51,20	2,00	0,65	0,75	1,10	2,25	2,50



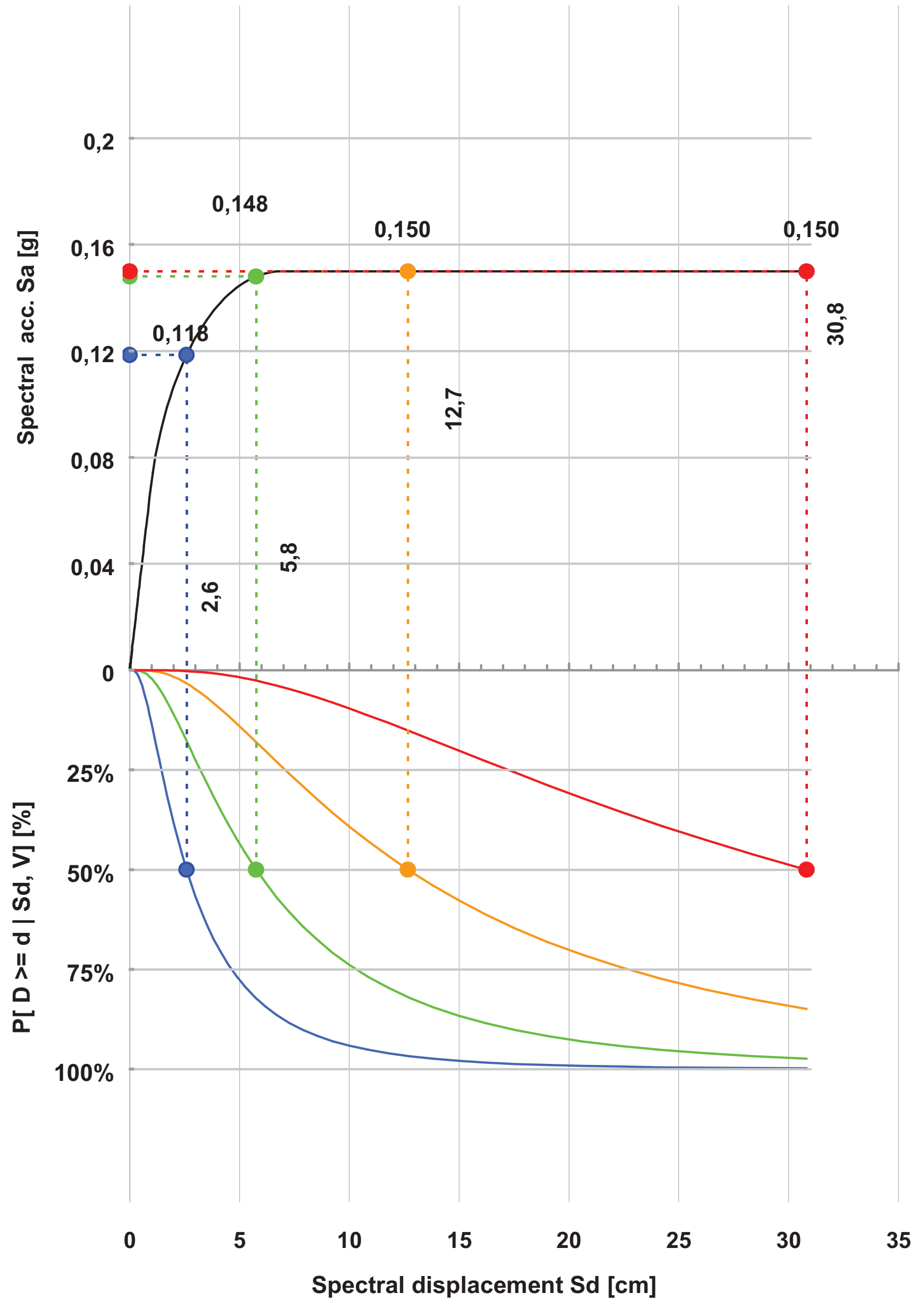
Masonry 1986-01; No. floors: 4

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,15	0,10	0,34	1,16	0,08	3,20	0,17	0,75	0,75	1,50	2,25	5,00
2	0,11	0,31	0,25	3,48	0,06	6,40	0,33	0,75	0,75	1,40	2,25	5,00
3	0,09	0,47	0,20	4,22	0,05	9,60	0,46	0,75	0,75	1,33	2,25	4,00
4	0,08	0,68	0,19	5,02	0,05	12,80	0,57	0,75	0,75	1,25	2,25	3,30
5-7	0,07	0,93	0,15	6,91	0,04	19,20	0,75	0,75	0,75	1,25	2,25	3,30
7-15	0,06	2,49	0,14	14,03	0,04	32,00	1,25	0,65	0,75	1,10	2,25	2,50
>15	0,06	6,39	0,14	35,92	0,04	51,20	2,00	0,65	0,75	1,10	2,25	2,50



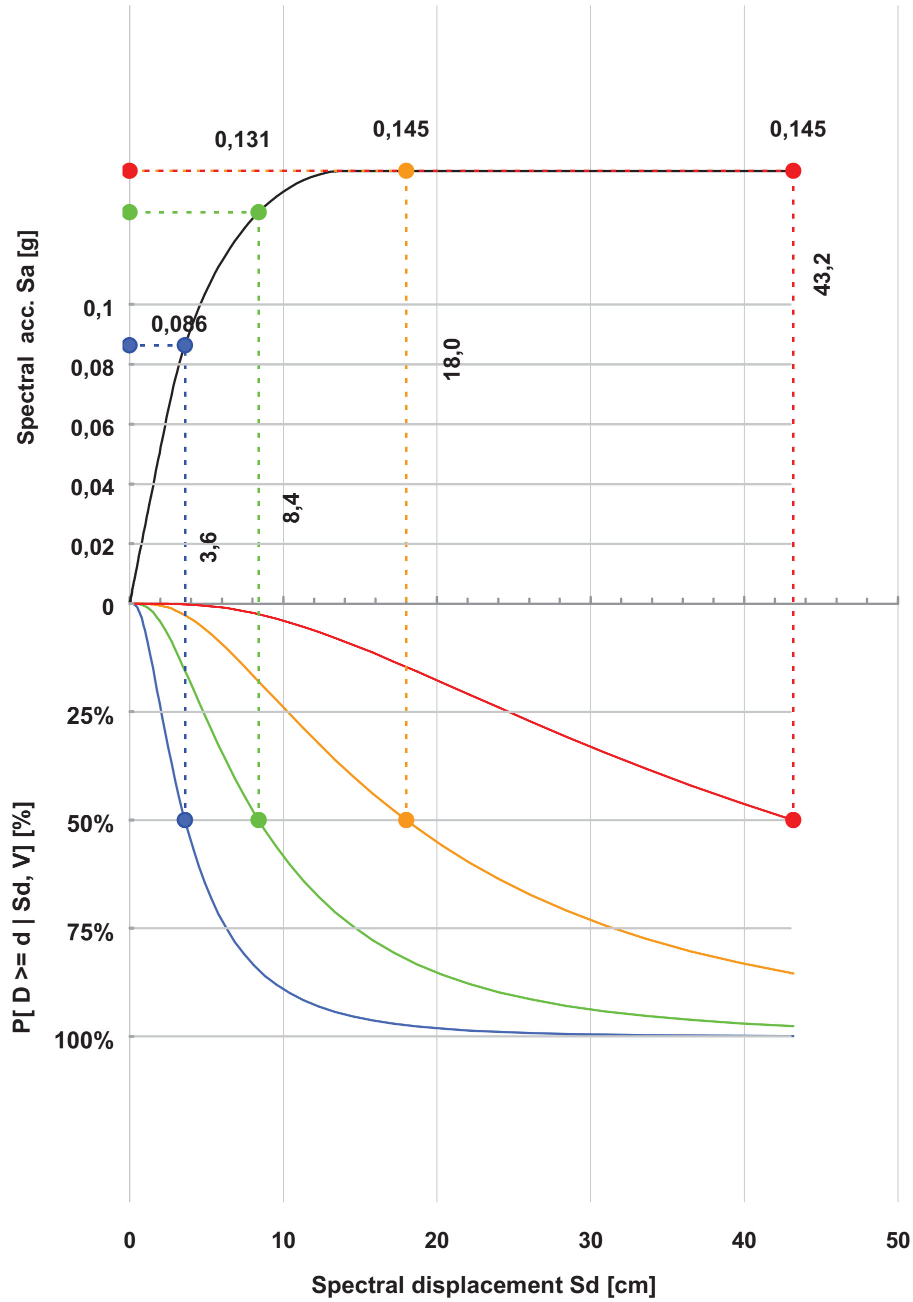
Masonry 1986-01; No. floors: 5-7

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,15	0,10	0,34	1,16	0,08	3,20	0,17	0,75	0,75	1,50	2,25	5,00
2	0,11	0,31	0,25	3,48	0,06	6,40	0,33	0,75	0,75	1,40	2,25	5,00
3	0,09	0,47	0,20	4,22	0,05	9,60	0,46	0,75	0,75	1,33	2,25	4,00
4	0,08	0,68	0,19	5,02	0,05	12,80	0,57	0,75	0,75	1,25	2,25	3,30
5-7	0,07	0,93	0,15	6,91	0,04	19,20	0,75	0,75	0,75	1,25	2,25	3,30
7-15	0,06	2,49	0,14	14,03	0,04	32,00	1,25	0,65	0,75	1,10	2,25	2,50
>15	0,06	6,39	0,14	35,92	0,04	51,20	2,00	0,65	0,75	1,10	2,25	2,50



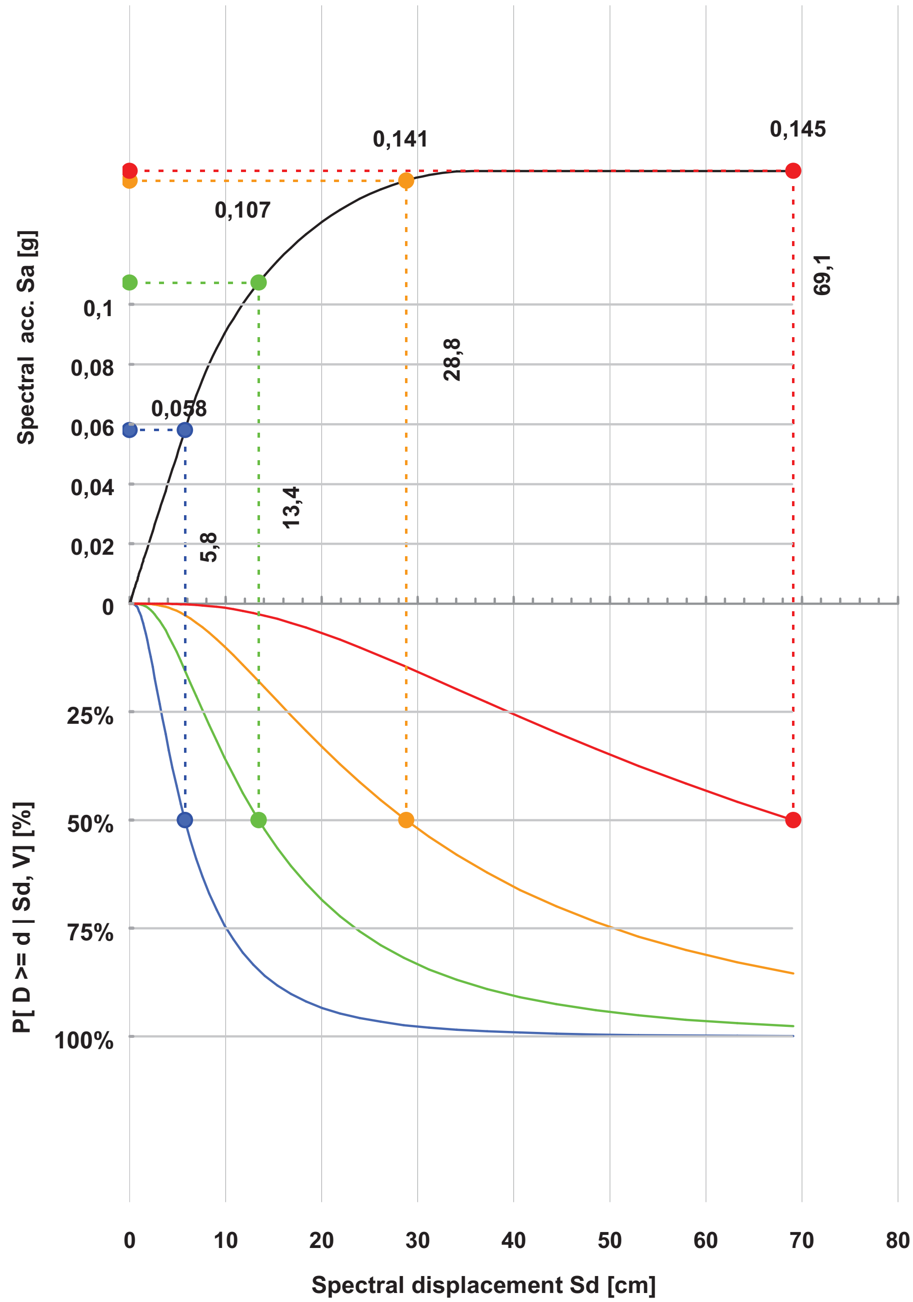
Masonry 1986-01; No. floors: 7-15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,15	0,10	0,34	1,16	0,08	3,20	0,17	0,75	0,75	1,50	2,25	5,00
2	0,11	0,31	0,25	3,48	0,06	6,40	0,33	0,75	0,75	1,40	2,25	5,00
3	0,09	0,47	0,20	4,22	0,05	9,60	0,46	0,75	0,75	1,33	2,25	4,00
4	0,08	0,68	0,19	5,02	0,05	12,80	0,57	0,75	0,75	1,25	2,25	3,30
5-7	0,07	0,93	0,15	6,91	0,04	19,20	0,75	0,75	0,75	1,25	2,25	3,30
7-15	0,06	2,49	0,14	14,03	0,04	32,00	1,25	0,65	0,75	1,10	2,25	2,50
>15	0,06	6,39	0,14	35,92	0,04	51,20	2,00	0,65	0,75	1,10	2,25	2,50



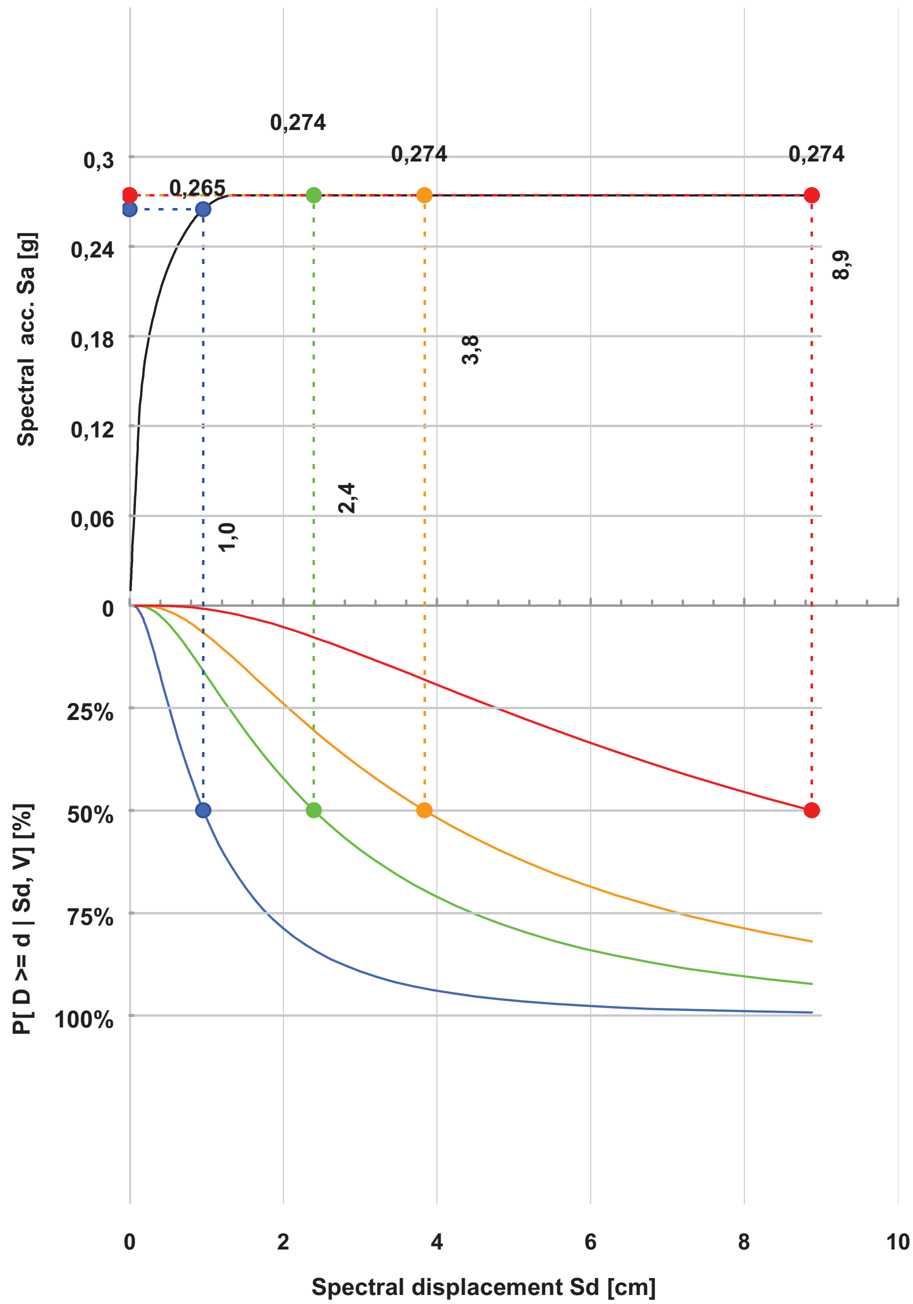
Masonry 1986-01; No. floors: >15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,15	0,10	0,34	1,16	0,08	3,20	0,17	0,75	0,75	1,50	2,25	5,00
2	0,11	0,31	0,25	3,48	0,06	6,40	0,33	0,75	0,75	1,40	2,25	5,00
3	0,09	0,47	0,20	4,22	0,05	9,60	0,46	0,75	0,75	1,33	2,25	4,00
4	0,08	0,68	0,19	5,02	0,05	12,80	0,57	0,75	0,75	1,25	2,25	3,30
5-7	0,07	0,93	0,15	6,91	0,04	19,20	0,75	0,75	0,75	1,25	2,25	3,30
7-15	0,06	2,49	0,14	14,03	0,04	32,00	1,25	0,65	0,75	1,10	2,25	2,50
>15	0,06	6,39	0,14	35,92	0,04	51,20	2,00	0,65	0,75	1,10	2,25	2,50



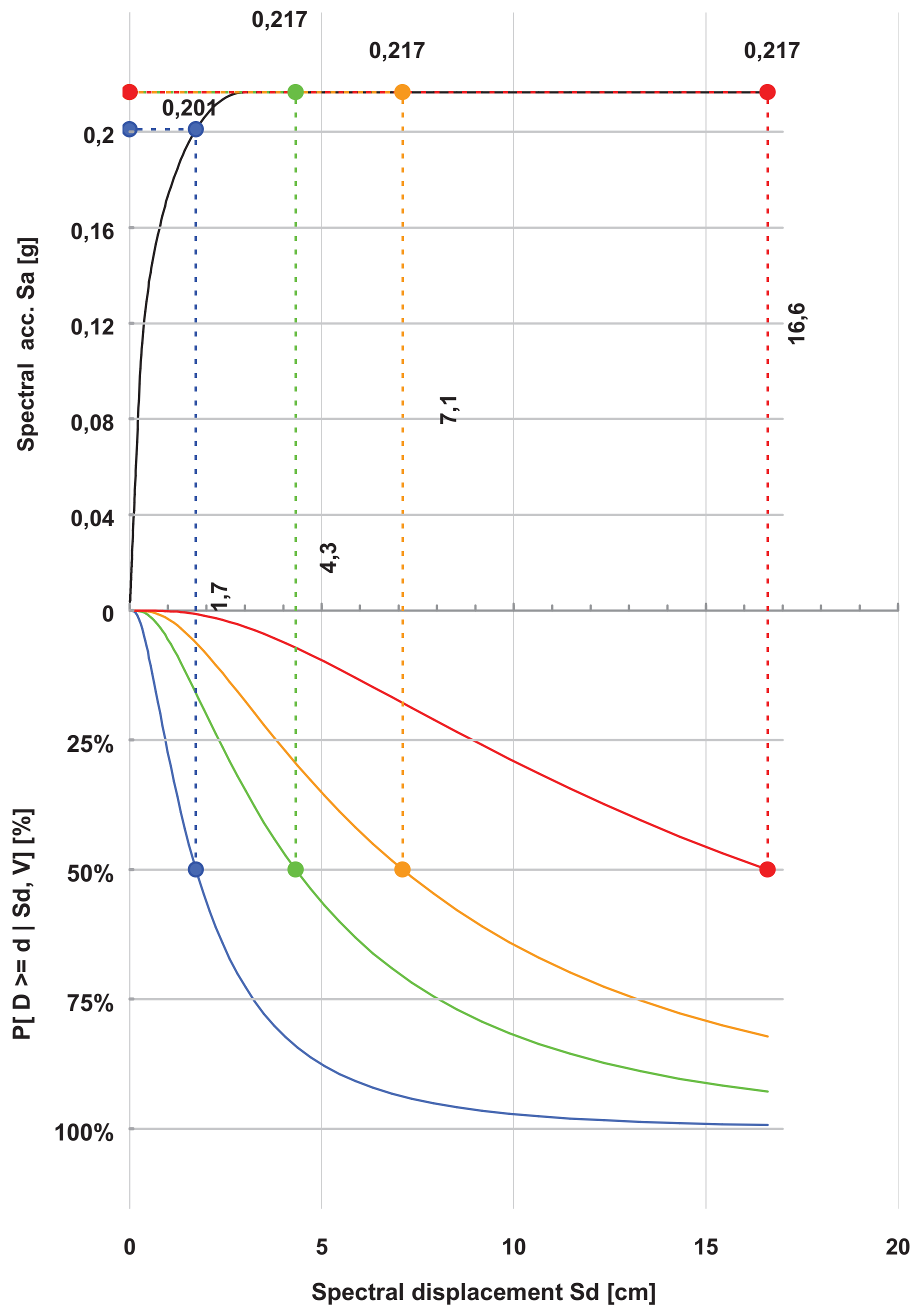
RC till 1960; No. floors: 1

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,12	0,12	0,27	1,36	0,07	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,10	0,27	0,22	2,99	0,06	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,08	0,38	0,19	4,26	0,05	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,07	0,57	0,16	5,13	0,05	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,07	0,82	0,15	6,12	0,04	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,06	1,56	0,14	8,78	0,04	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,06	3,50	0,12	19,66	0,04	51,20	1,60	0,70	0,60	1,10	2,25	2,50



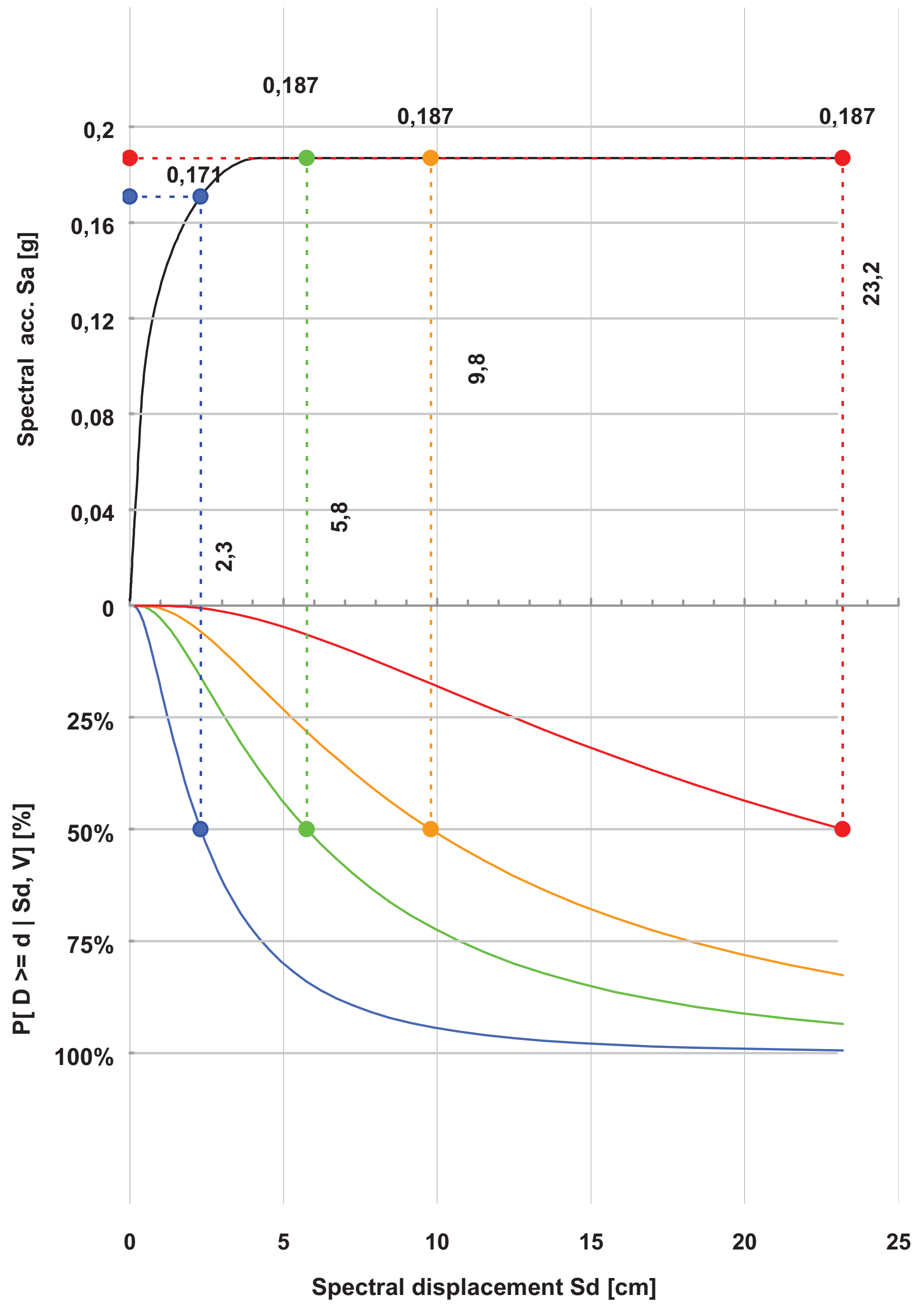
RC till 1960; No. floors: 2

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,12	0,12	0,27	1,36	0,07	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,10	0,27	0,22	2,99	0,06	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,08	0,38	0,19	4,26	0,05	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,07	0,57	0,16	5,13	0,05	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,07	0,82	0,15	6,12	0,04	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,06	1,56	0,14	8,78	0,04	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,06	3,50	0,12	19,66	0,04	51,20	1,60	0,70	0,60	1,10	2,25	2,50



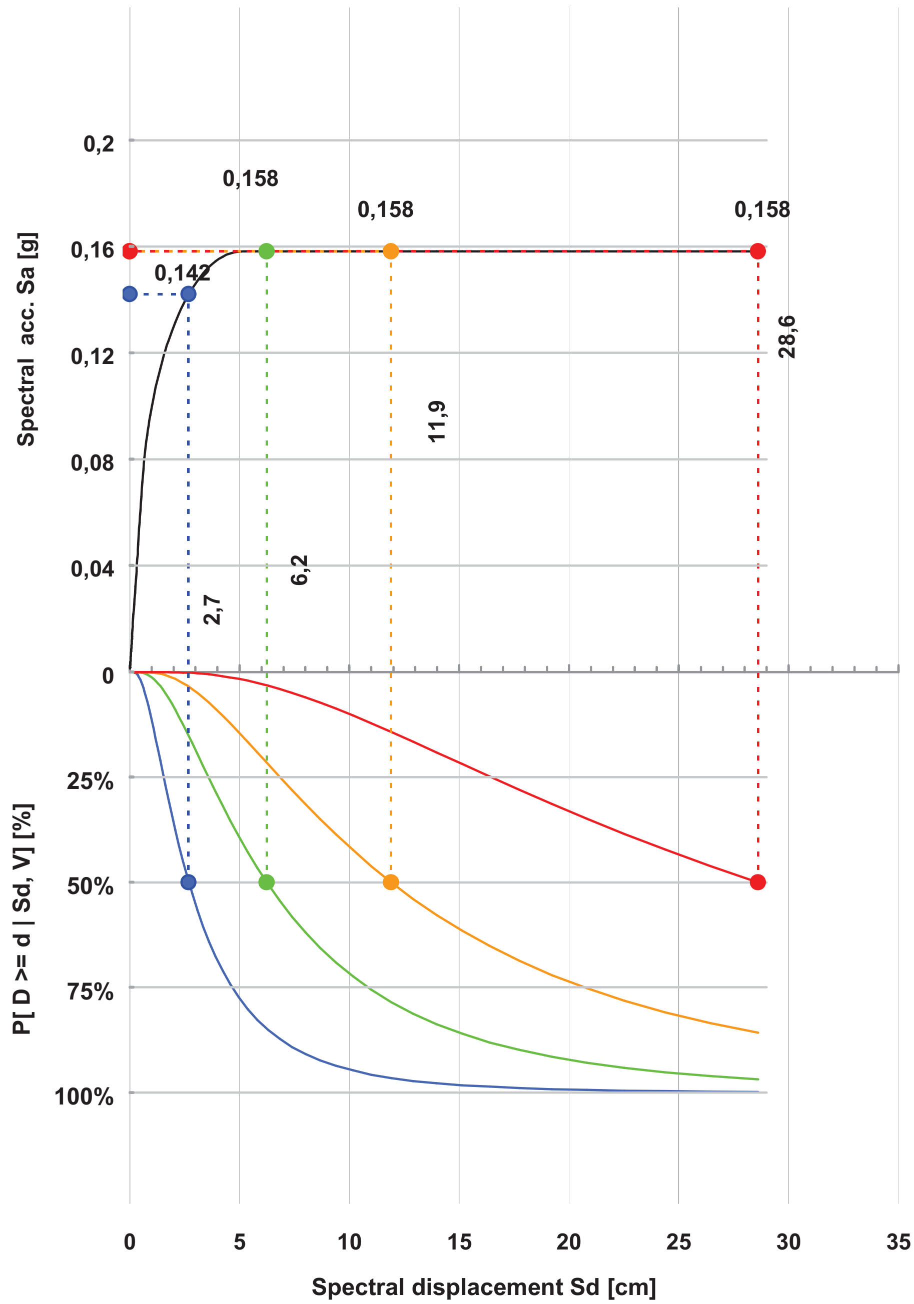
RC till 1960; No. floors: 3

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,12	0,12	0,27	1,36	0,07	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,10	0,27	0,22	2,99	0,06	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,08	0,38	0,19	4,26	0,05	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,07	0,57	0,16	5,13	0,05	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,07	0,82	0,15	6,12	0,04	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,06	1,56	0,14	8,78	0,04	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,06	3,50	0,12	19,66	0,04	51,20	1,60	0,70	0,60	1,10	2,25	2,50



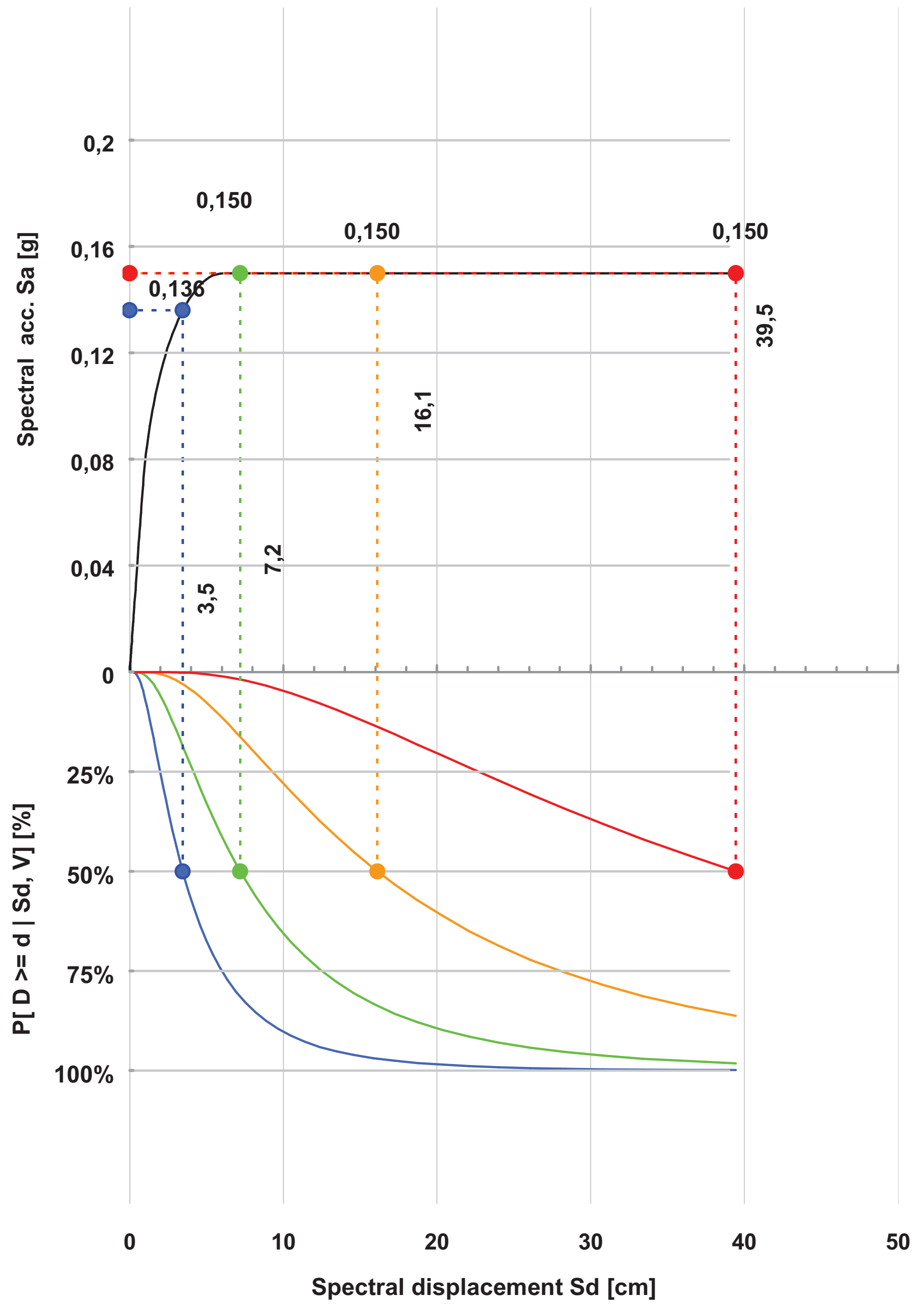
RC till 1960; No. floors: 4

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,12	0,12	0,27	1,36	0,07	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,10	0,27	0,22	2,99	0,06	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,08	0,38	0,19	4,26	0,05	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,07	0,57	0,16	5,13	0,05	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,07	0,82	0,15	6,12	0,04	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,06	1,56	0,14	8,78	0,04	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,06	3,50	0,12	19,66	0,04	51,20	1,60	0,70	0,60	1,10	2,25	2,50



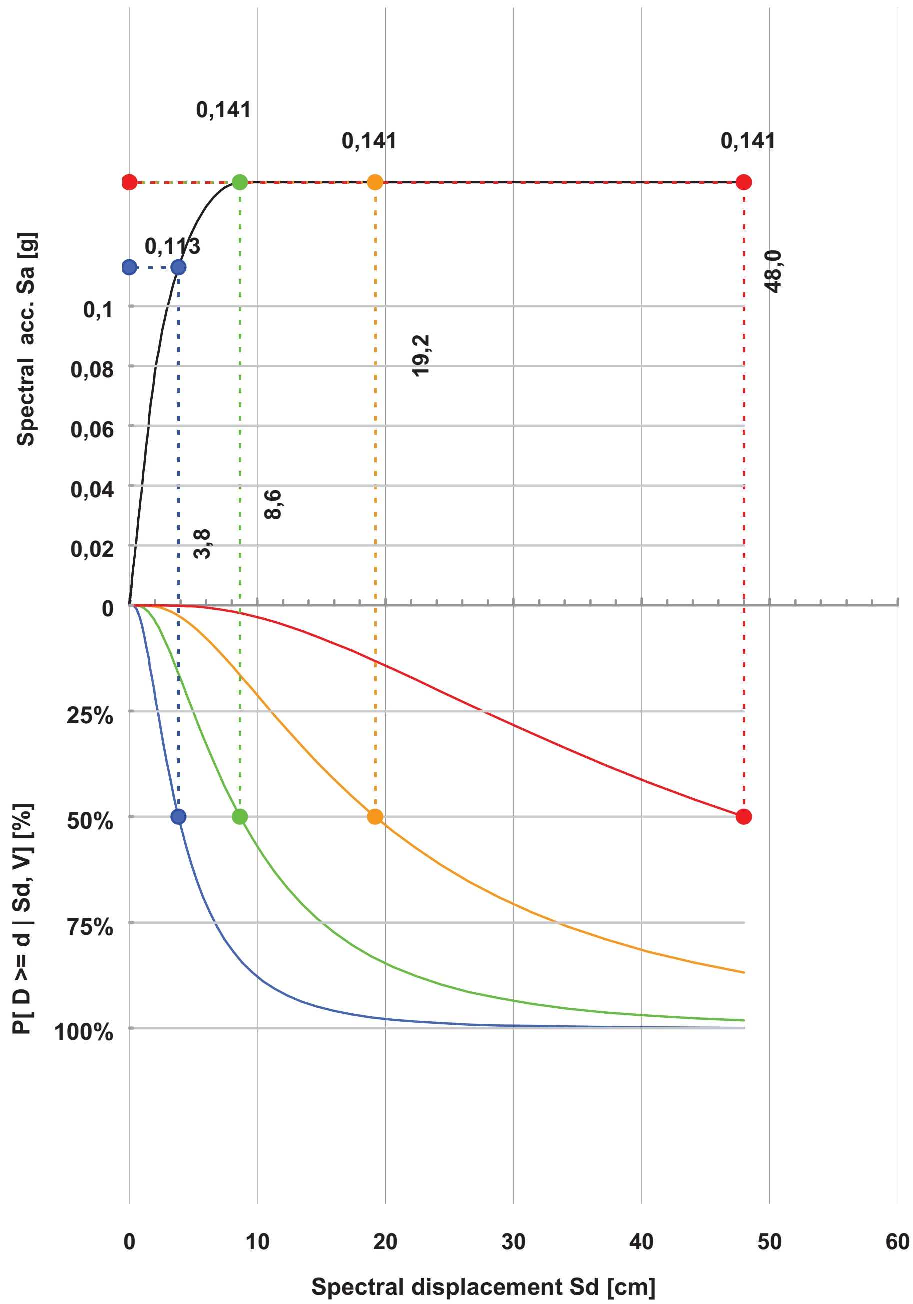
RC till 1960; No. floors: 5-7

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,12	0,12	0,27	1,36	0,07	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,10	0,27	0,22	2,99	0,06	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,08	0,38	0,19	4,26	0,05	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,07	0,57	0,16	5,13	0,05	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,07	0,82	0,15	6,12	0,04	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,06	1,56	0,14	8,78	0,04	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,06	3,50	0,12	19,66	0,04	51,20	1,60	0,70	0,60	1,10	2,25	2,50



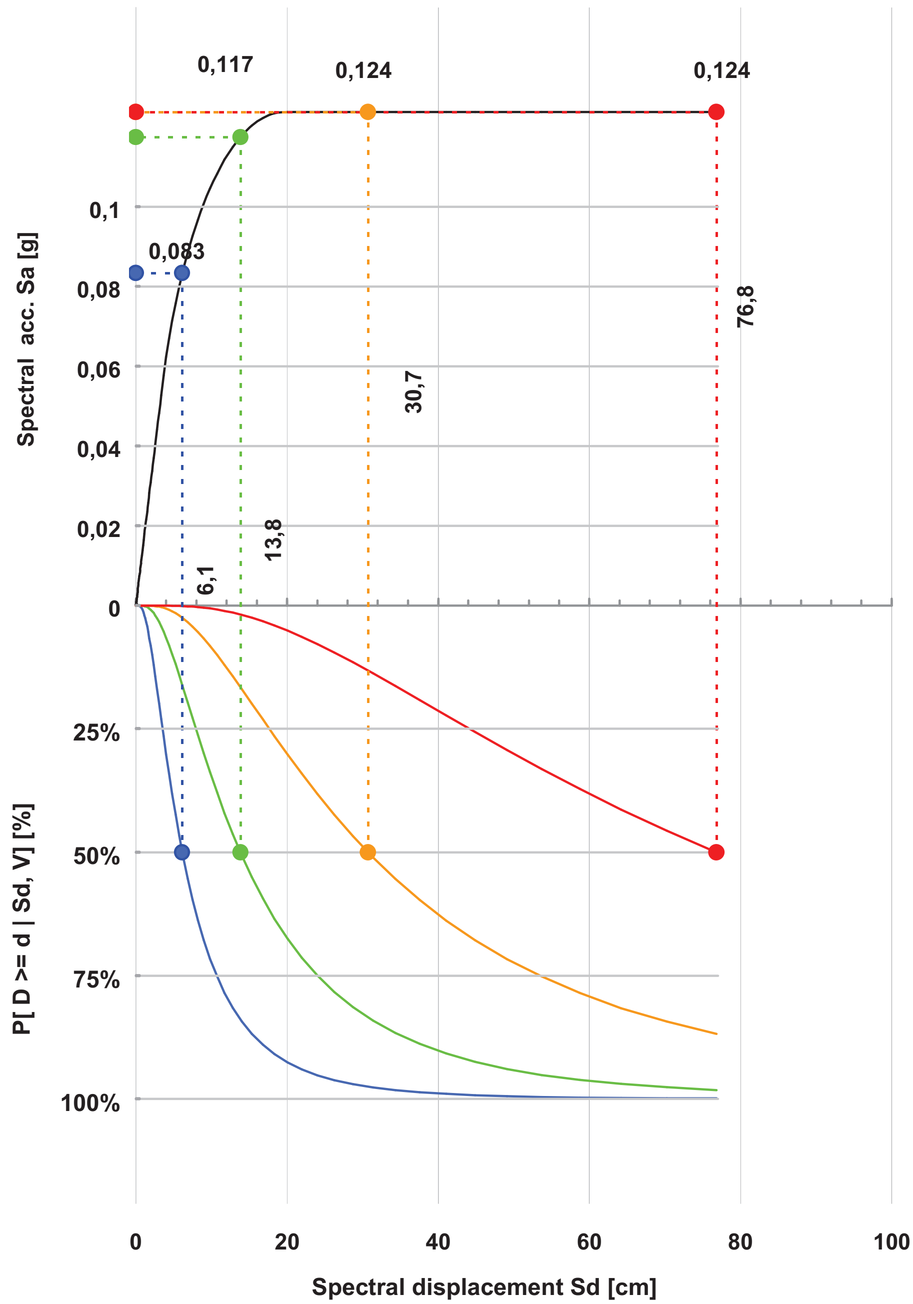
RC till 1960; No. floors: 7-15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,12	0,12	0,27	1,36	0,07	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,10	0,27	0,22	2,99	0,06	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,08	0,38	0,19	4,26	0,05	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,07	0,57	0,16	5,13	0,05	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,07	0,82	0,15	6,12	0,04	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,06	1,56	0,14	8,78	0,04	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,06	3,50	0,12	19,66	0,04	51,20	1,60	0,70	0,60	1,10	2,25	2,50



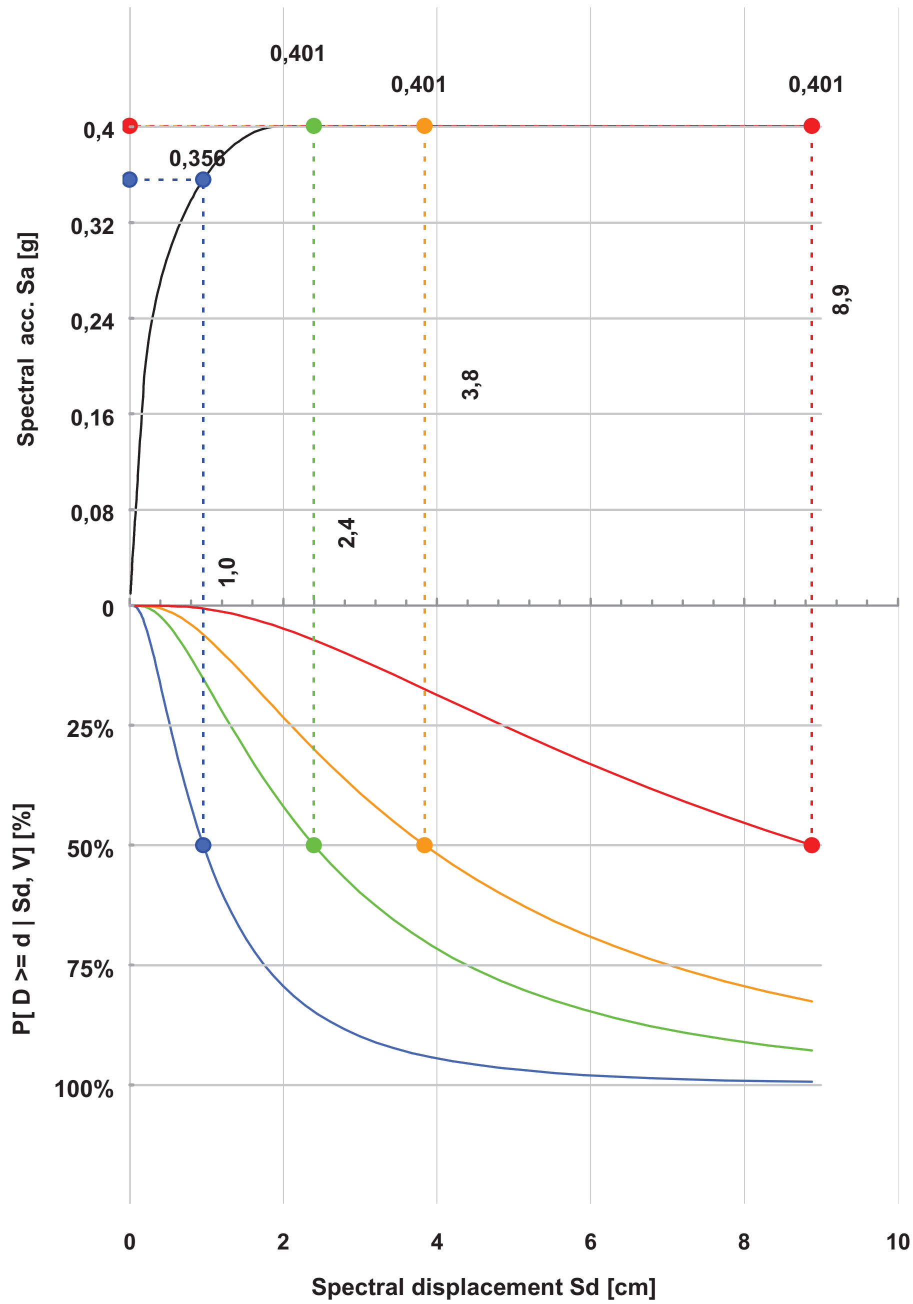
RC till 1960; No. floors: >15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,12	0,12	0,27	1,36	0,07	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,10	0,27	0,22	2,99	0,06	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,08	0,38	0,19	4,26	0,05	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,07	0,57	0,16	5,13	0,05	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,07	0,82	0,15	6,12	0,04	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,06	1,56	0,14	8,78	0,04	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,06	3,50	0,12	19,66	0,04	51,20	1,60	0,70	0,60	1,10	2,25	2,50



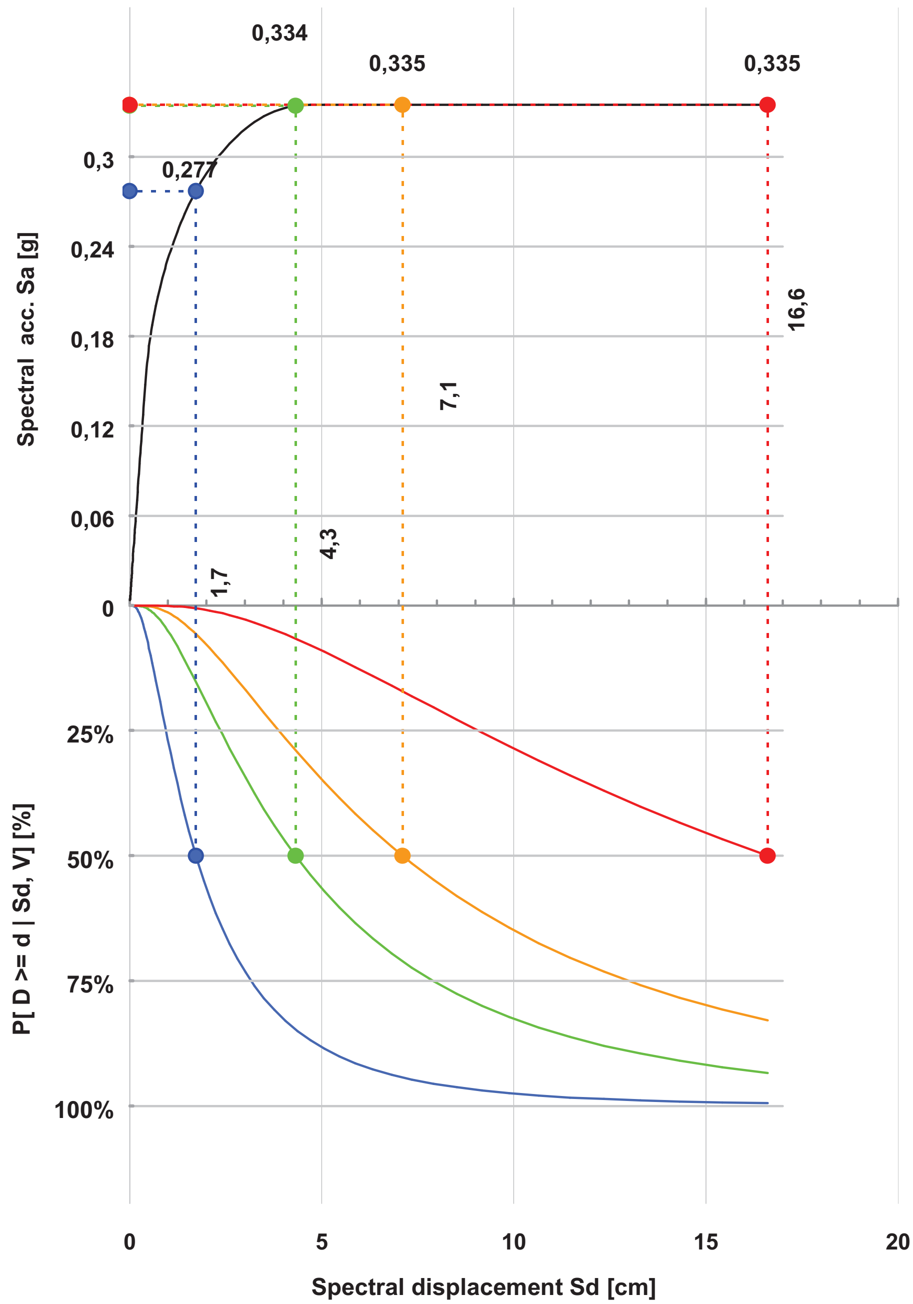
RC 1961-85; No. floors: 1

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,18	0,18	0,40	1,99	0,10	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,15	0,41	0,33	4,62	0,09	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,12	0,57	0,28	6,40	0,08	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,11	0,85	0,24	7,69	0,07	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,10	1,24	0,23	9,18	0,06	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,09	2,34	0,21	13,17	0,06	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,09	5,99	0,21	33,70	0,06	51,20	1,60	0,70	0,60	1,10	2,25	2,50



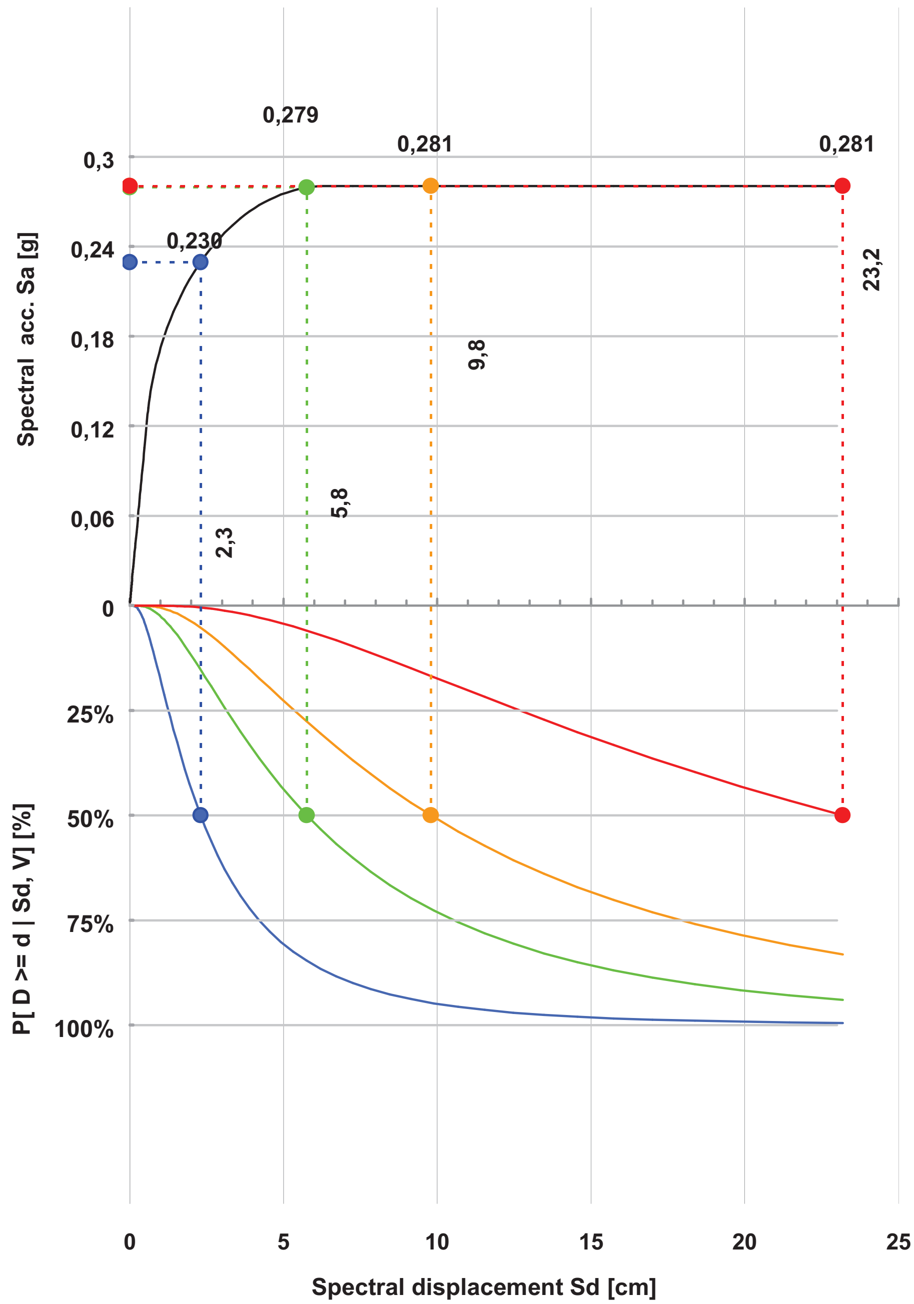
RC 1961-85; No. floors: 2

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,18	0,18	0,40	1,99	0,10	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,15	0,41	0,33	4,62	0,09	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,12	0,57	0,28	6,40	0,08	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,11	0,85	0,24	7,69	0,07	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,10	1,24	0,23	9,18	0,06	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,09	2,34	0,21	13,17	0,06	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,09	5,99	0,21	33,70	0,06	51,20	1,60	0,70	0,60	1,10	2,25	2,50



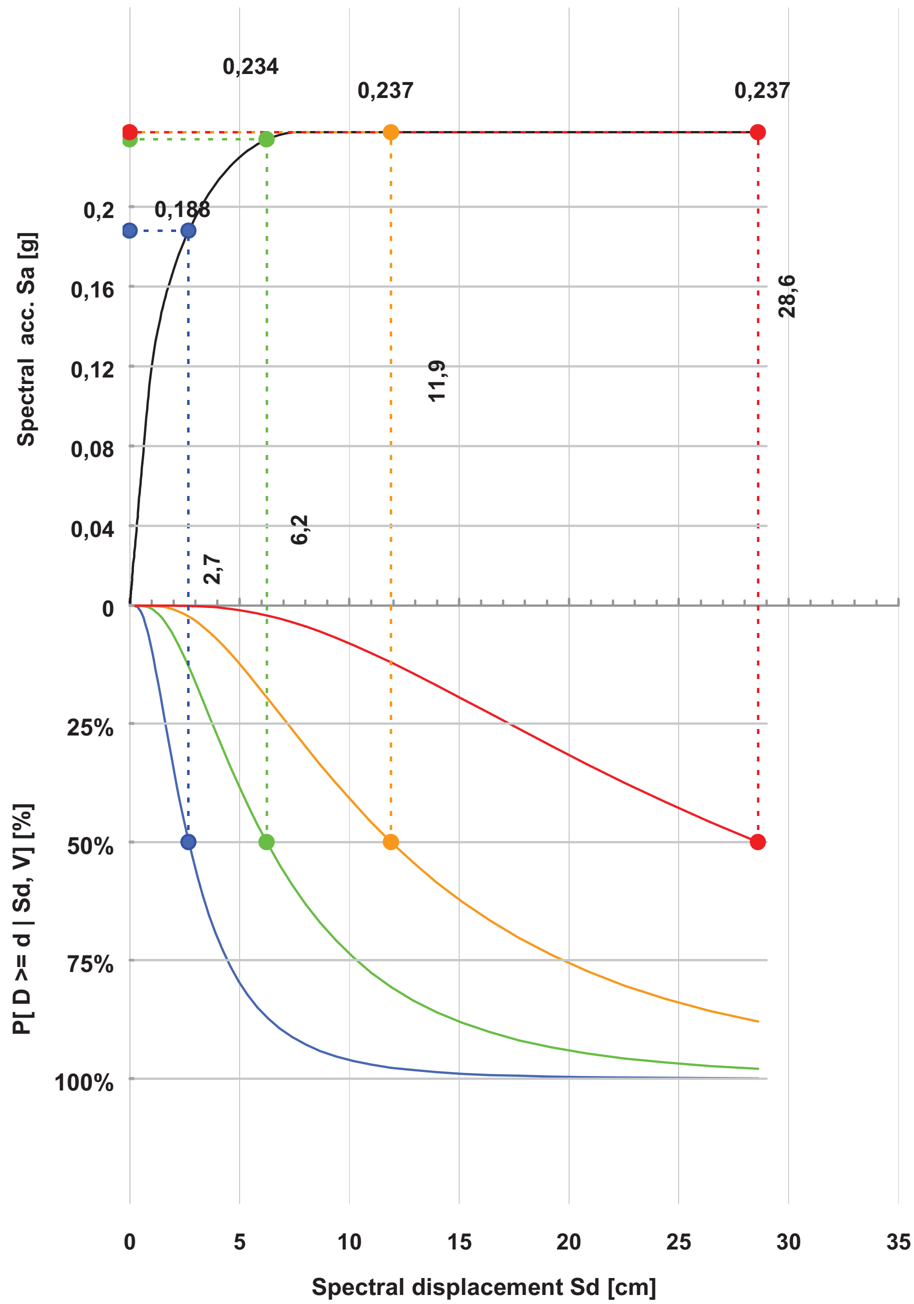
RC 1961-85; No. floors: 3

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,18	0,18	0,40	1,99	0,10	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,15	0,41	0,33	4,62	0,09	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,12	0,57	0,28	6,40	0,08	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,11	0,85	0,24	7,69	0,07	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,10	1,24	0,23	9,18	0,06	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,09	2,34	0,21	13,17	0,06	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,09	5,99	0,21	33,70	0,06	51,20	1,60	0,70	0,60	1,10	2,25	2,50



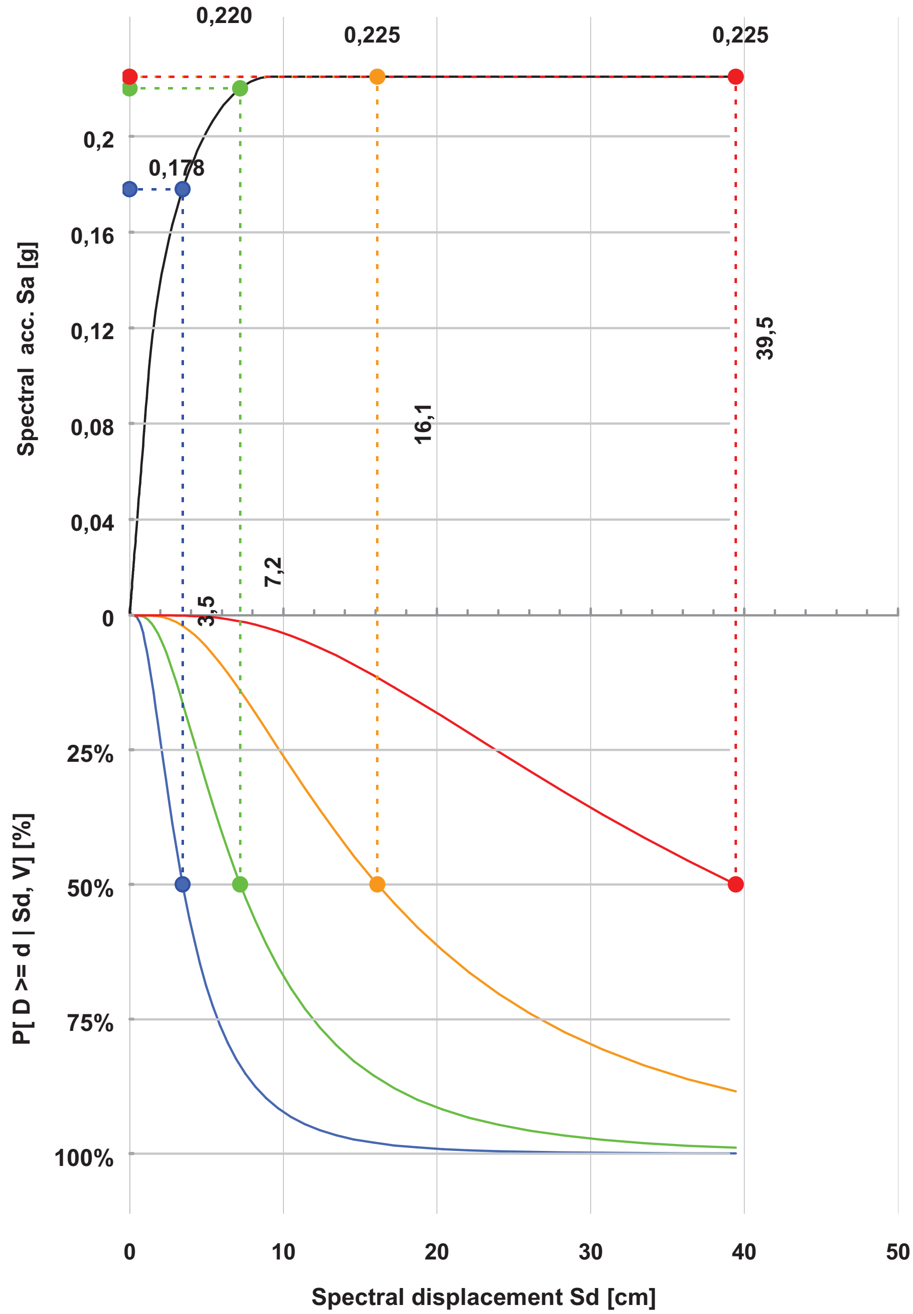
RC 1961-85; No. floors: 4

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,18	0,18	0,40	1,99	0,10	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,15	0,41	0,33	4,62	0,09	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,12	0,57	0,28	6,40	0,08	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,11	0,85	0,24	7,69	0,07	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,10	1,24	0,23	9,18	0,06	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,09	2,34	0,21	13,17	0,06	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,09	5,99	0,21	33,70	0,06	51,20	1,60	0,70	0,60	1,10	2,25	2,50



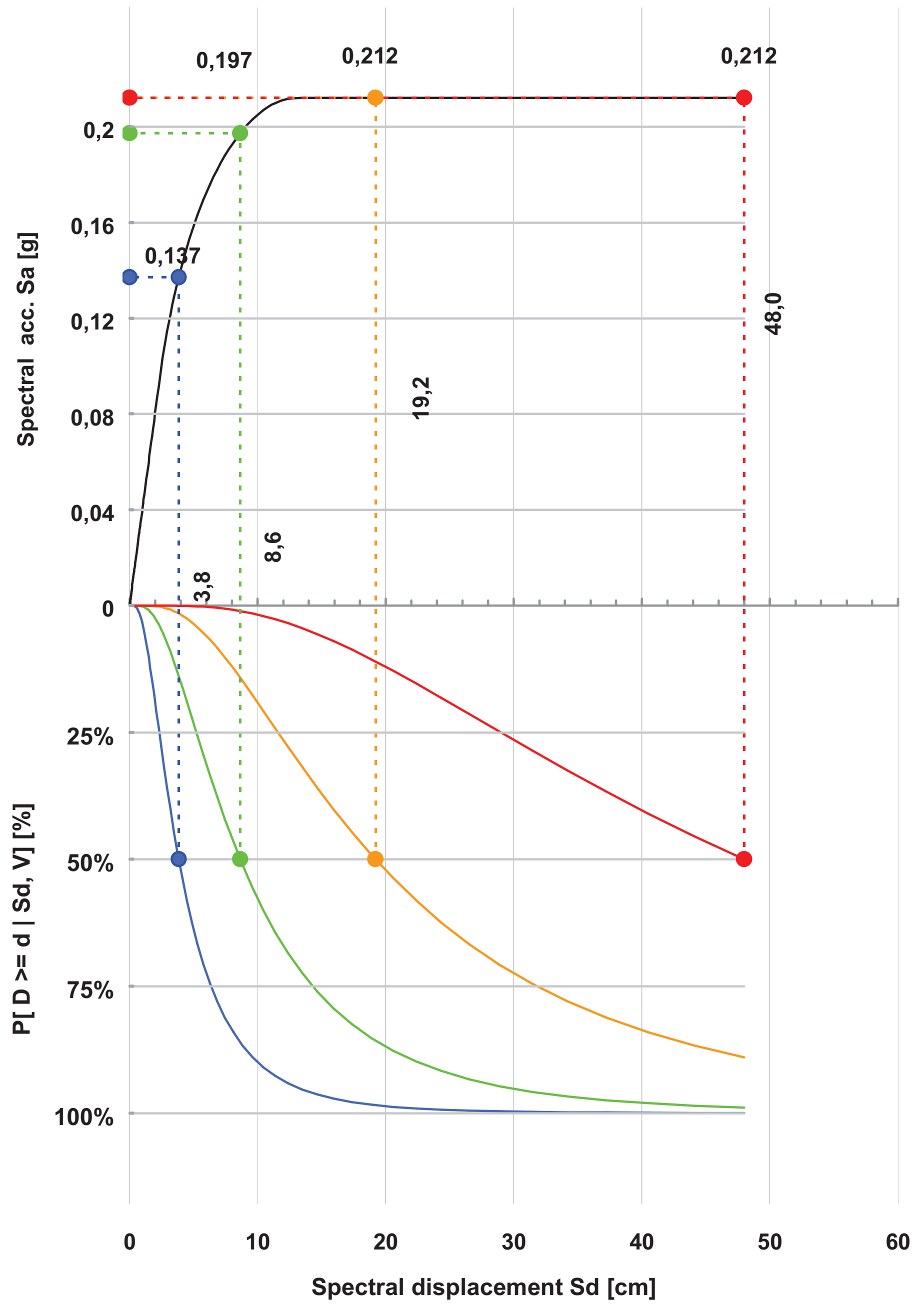
RC 1961-85; No. floors: 5-7

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,18	0,18	0,40	1,99	0,10	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,15	0,41	0,33	4,62	0,09	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,12	0,57	0,28	6,40	0,08	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,11	0,85	0,24	7,69	0,07	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,10	1,24	0,23	9,18	0,06	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,09	2,34	0,21	13,17	0,06	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,09	5,99	0,21	33,70	0,06	51,20	1,60	0,70	0,60	1,10	2,25	2,50



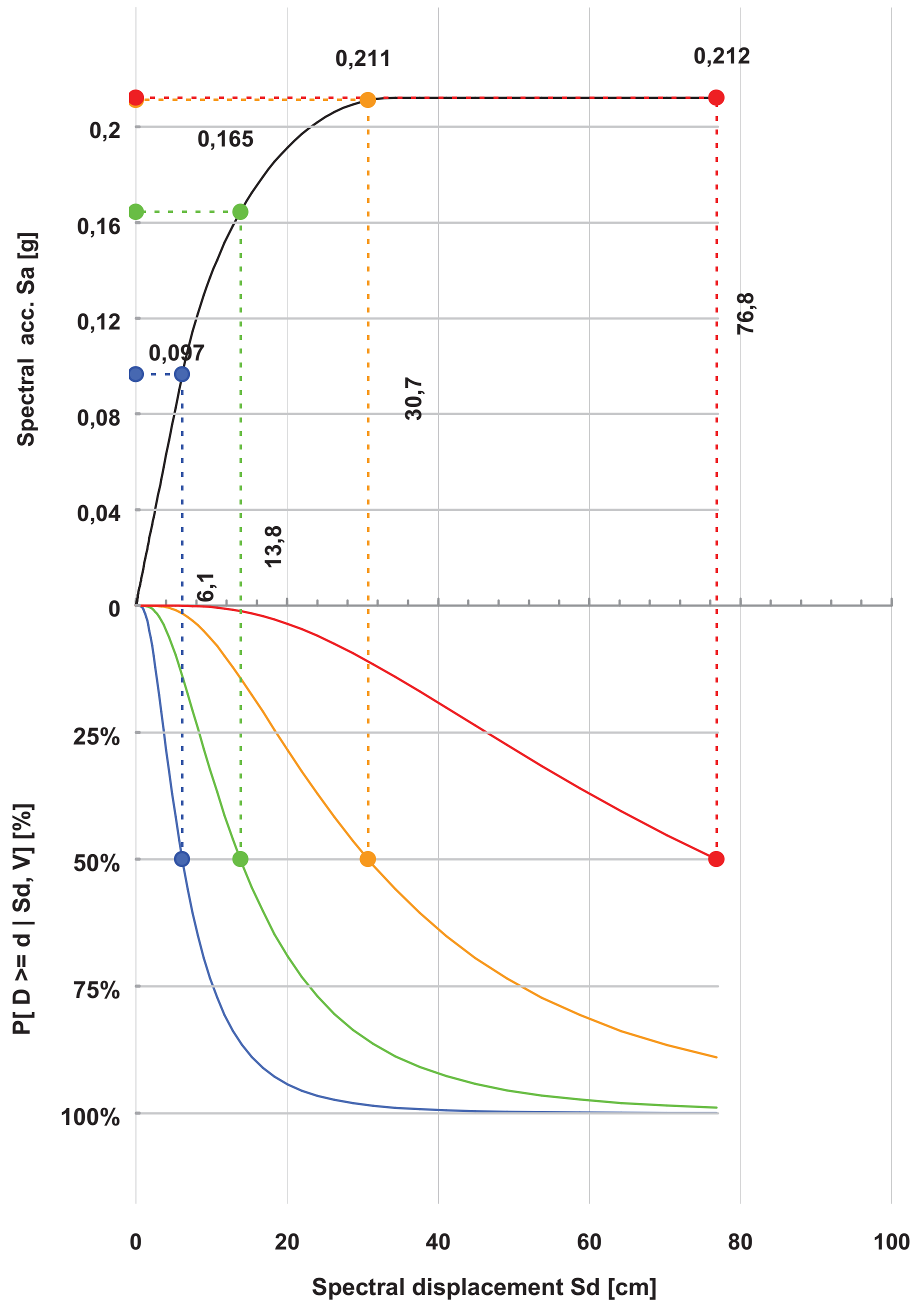
RC 1961-85; No. floors: 7-15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,18	0,18	0,40	1,99	0,10	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,15	0,41	0,33	4,62	0,09	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,12	0,57	0,28	6,40	0,08	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,11	0,85	0,24	7,69	0,07	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,10	1,24	0,23	9,18	0,06	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,09	2,34	0,21	13,17	0,06	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,09	5,99	0,21	33,70	0,06	51,20	1,60	0,70	0,60	1,10	2,25	2,50



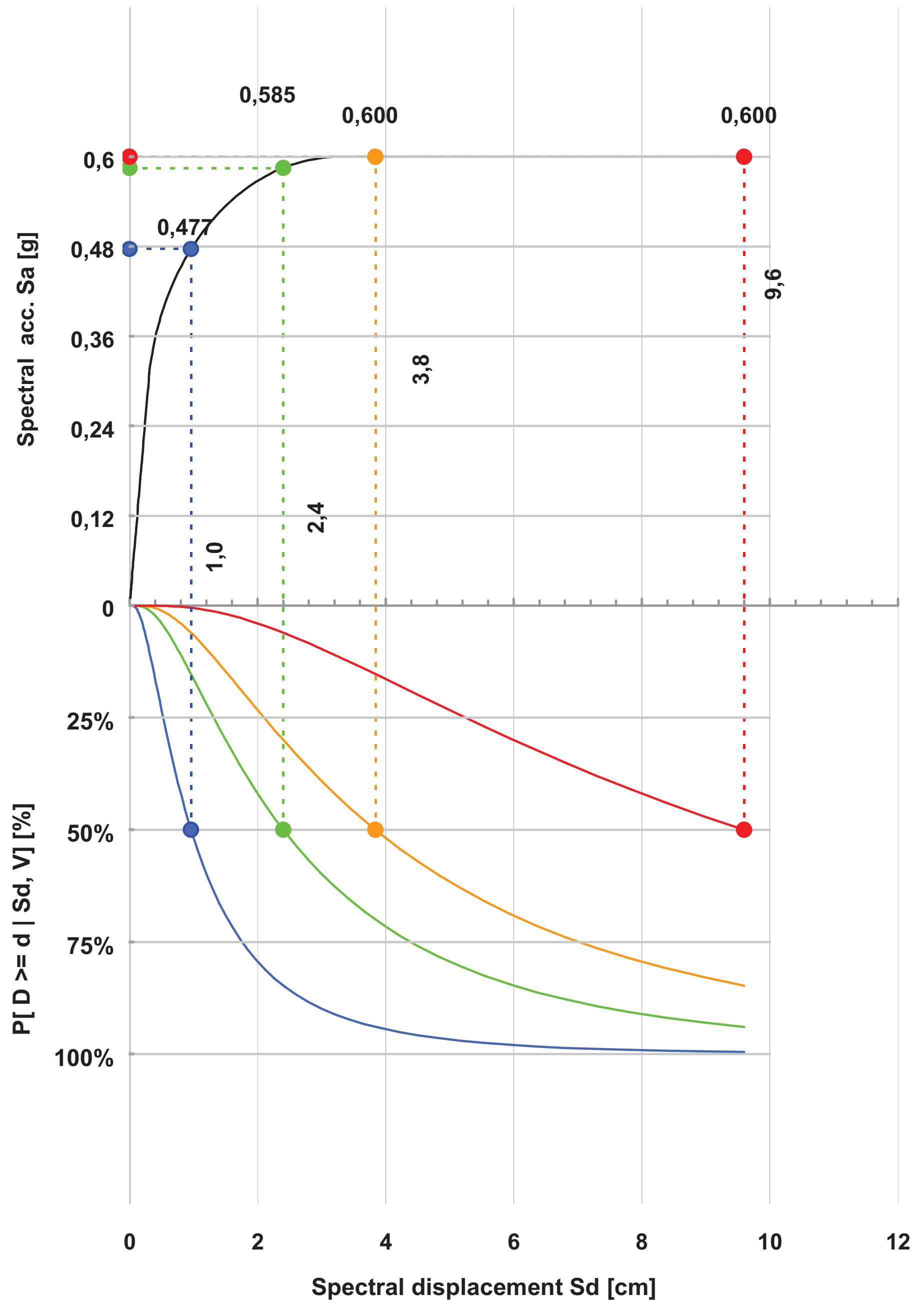
RC 1961-85; No. floors: >15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,18	0,18	0,40	1,99	0,10	3,20	0,20	0,80	0,75	1,50	2,25	5,00
2	0,15	0,41	0,33	4,62	0,09	6,40	0,33	0,80	0,75	1,40	2,25	5,00
3	0,12	0,57	0,28	6,40	0,08	9,60	0,43	0,80	0,75	1,33	2,25	5,00
4	0,11	0,85	0,24	7,69	0,07	12,80	0,57	0,80	0,75	1,25	2,25	4,00
5-7	0,10	1,24	0,23	9,18	0,06	19,20	0,71	0,75	0,75	1,25	2,25	3,30
7-15	0,09	2,34	0,21	13,17	0,06	32,00	1,00	0,70	0,60	1,10	2,25	2,50
>15	0,09	5,99	0,21	33,70	0,06	51,20	1,60	0,70	0,60	1,10	2,25	2,50



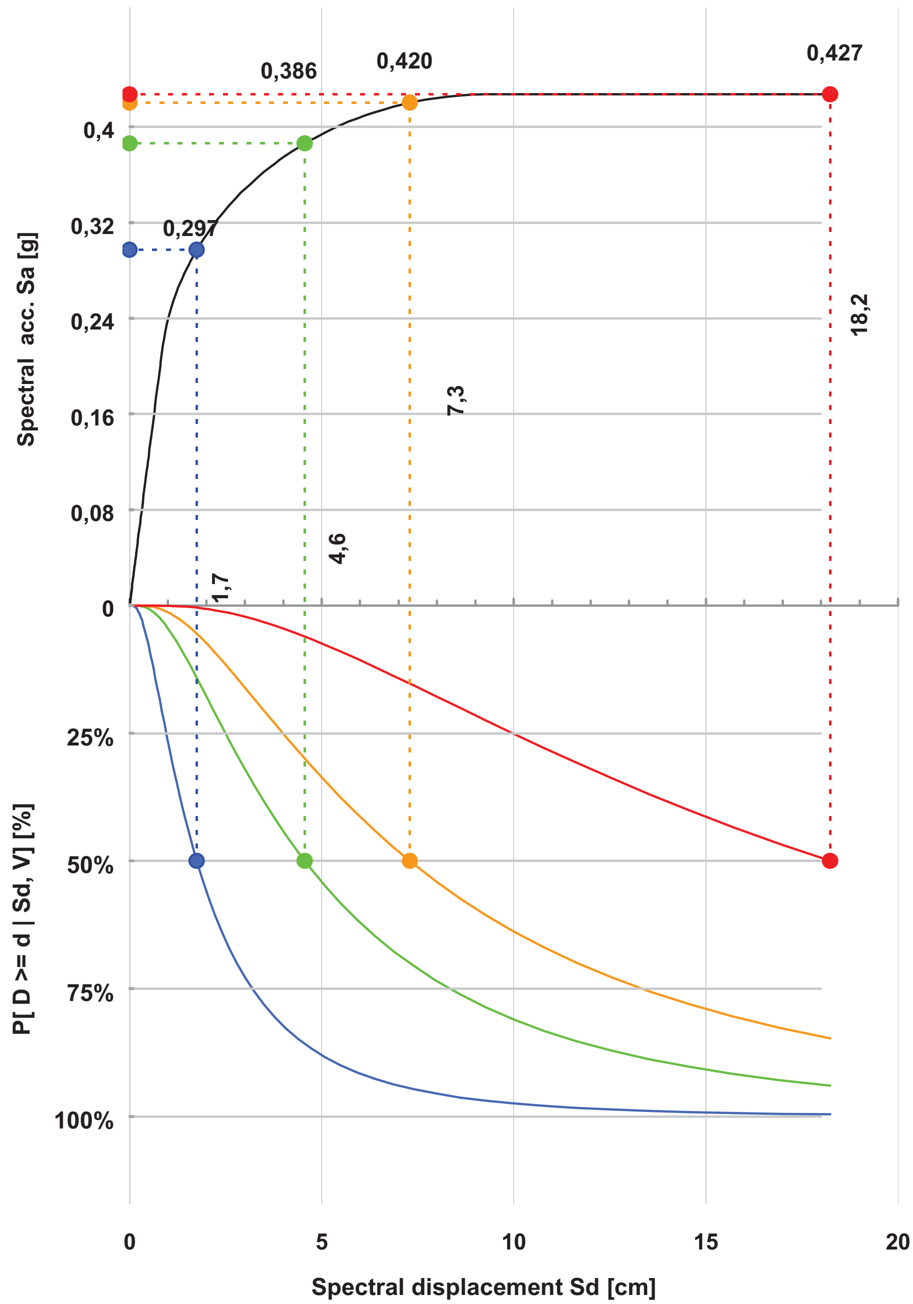
RC 1986-01; No. floors: 1

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,30	0,30	0,60	3,28	0,16	3,20	0,20	0,80	0,75	1,50	2,00	5,50
2	0,21	0,85	0,43	9,33	0,12	6,40	0,40	0,80	0,75	1,40	2,00	5,50
3	0,16	1,22	0,33	11,67	0,10	9,60	0,55	0,80	0,75	1,33	2,00	4,80
4	0,16	1,81	0,33	13,05	0,10	12,80	0,67	0,78	0,75	1,30	2,00	3,60
5-7	0,16	2,92	0,32	21,01	0,10	19,20	0,86	0,75	0,75	1,25	2,00	3,60
7-15	0,14	5,45	0,28	30,53	0,09	32,00	1,25	0,70	0,60	1,10	2,00	2,80
>15	0,08	8,20	0,17	45,92	0,05	51,20	2,00	0,70	0,60	1,10	2,00	2,80



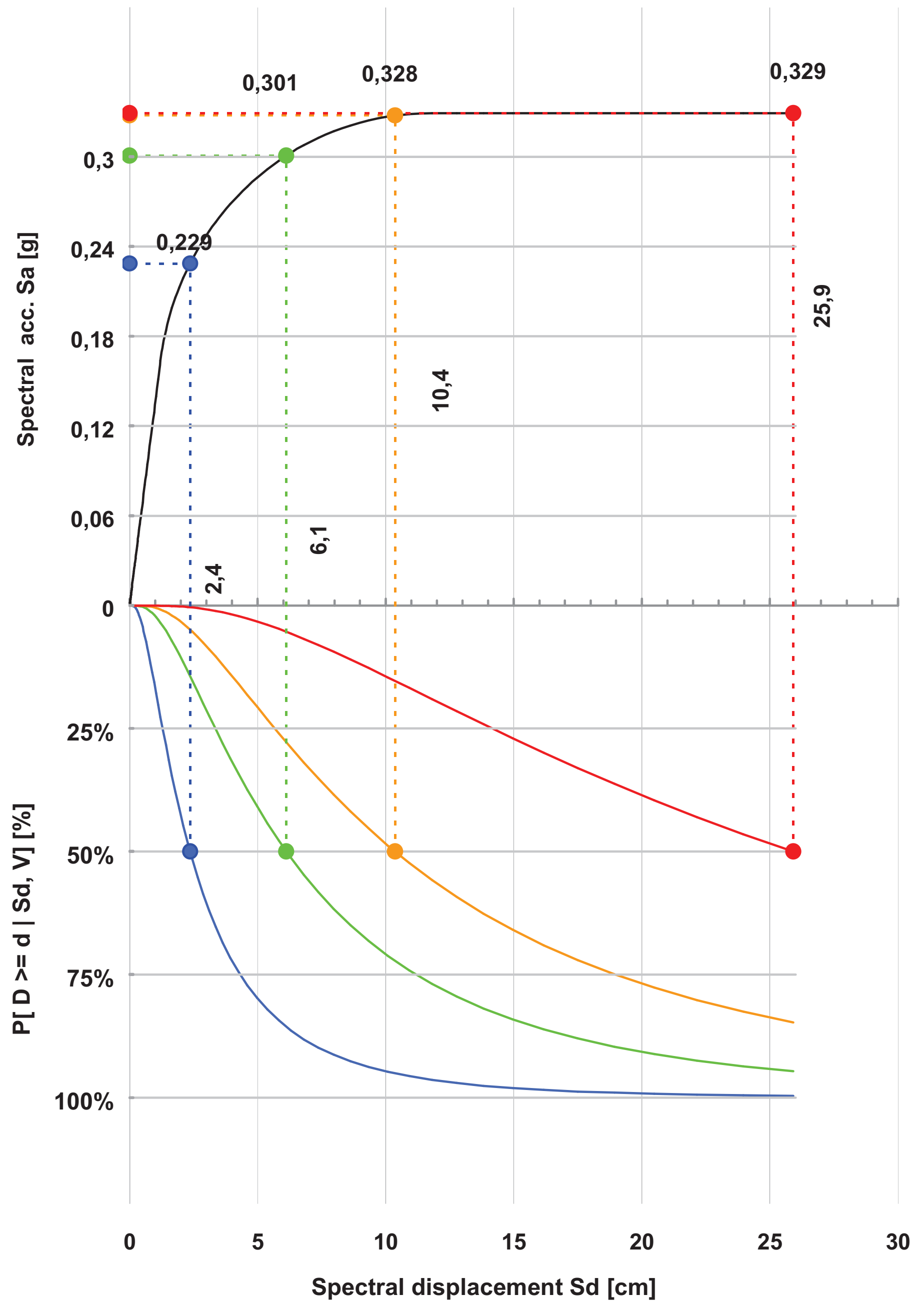
RC 1986-01; No. floors: 2

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,30	0,30	0,60	3,28	0,16	3,20	0,20	0,80	0,75	1,50	2,00	5,50
2	0,21	0,85	0,43	9,33	0,12	6,40	0,40	0,80	0,75	1,40	2,00	5,50
3	0,16	1,22	0,33	11,67	0,10	9,60	0,55	0,80	0,75	1,33	2,00	4,80
4	0,16	1,81	0,33	13,05	0,10	12,80	0,67	0,78	0,75	1,30	2,00	3,60
5-7	0,16	2,92	0,32	21,01	0,10	19,20	0,86	0,75	0,75	1,25	2,00	3,60
7-15	0,14	5,45	0,28	30,53	0,09	32,00	1,25	0,70	0,60	1,10	2,00	2,80
>15	0,08	8,20	0,17	45,92	0,05	51,20	2,00	0,70	0,60	1,10	2,00	2,80



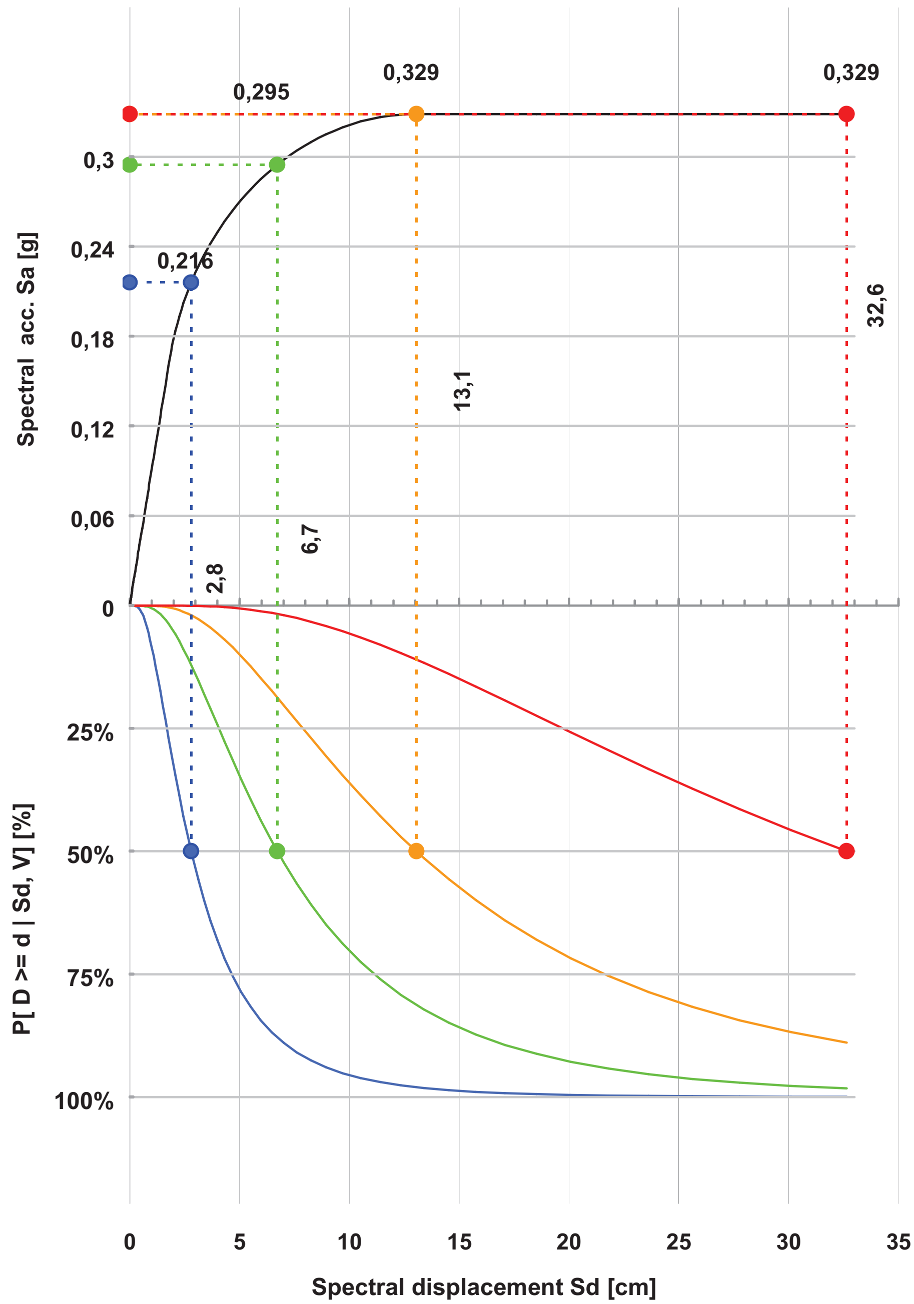
RC 1986-01; No. floors: 3

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,30	0,30	0,60	3,28	0,16	3,20	0,20	0,80	0,75	1,50	2,00	5,50
2	0,21	0,85	0,43	9,33	0,12	6,40	0,40	0,80	0,75	1,40	2,00	5,50
3	0,16	1,22	0,33	11,67	0,10	9,60	0,55	0,80	0,75	1,33	2,00	4,80
4	0,16	1,81	0,33	13,05	0,10	12,80	0,67	0,78	0,75	1,30	2,00	3,60
5-7	0,16	2,92	0,32	21,01	0,10	19,20	0,86	0,75	0,75	1,25	2,00	3,60
7-15	0,14	5,45	0,28	30,53	0,09	32,00	1,25	0,70	0,60	1,10	2,00	2,80
>15	0,08	8,20	0,17	45,92	0,05	51,20	2,00	0,70	0,60	1,10	2,00	2,80



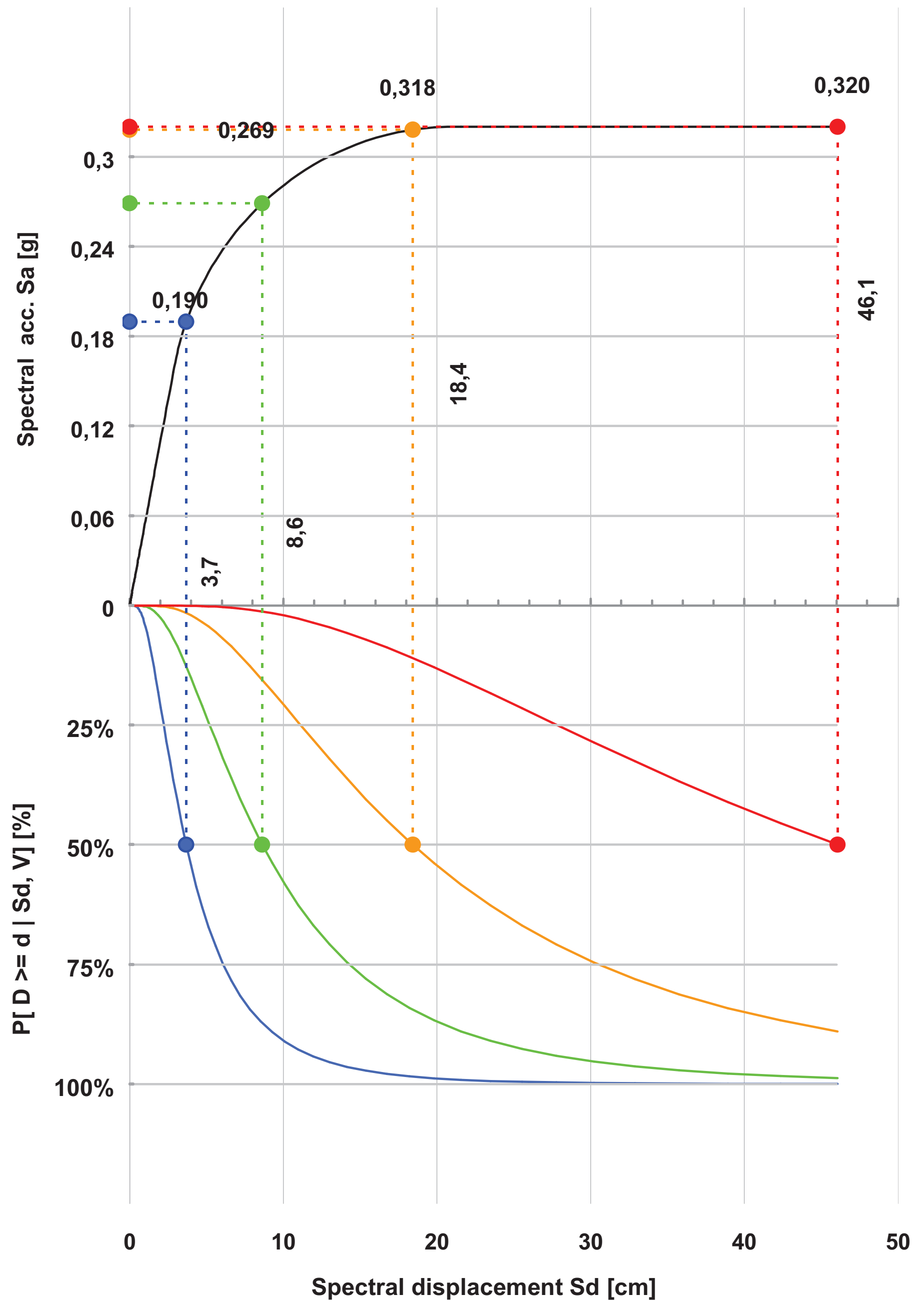
RC 1986-01; No. floors: 4

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,30	0,30	0,60	3,28	0,16	3,20	0,20	0,80	0,75	1,50	2,00	5,50
2	0,21	0,85	0,43	9,33	0,12	6,40	0,40	0,80	0,75	1,40	2,00	5,50
3	0,16	1,22	0,33	11,67	0,10	9,60	0,55	0,80	0,75	1,33	2,00	4,80
4	0,16	1,81	0,33	13,05	0,10	12,80	0,67	0,78	0,75	1,30	2,00	3,60
5-7	0,16	2,92	0,32	21,01	0,10	19,20	0,86	0,75	0,75	1,25	2,00	3,60
7-15	0,14	5,45	0,28	30,53	0,09	32,00	1,25	0,70	0,60	1,10	2,00	2,80
>15	0,08	8,20	0,17	45,92	0,05	51,20	2,00	0,70	0,60	1,10	2,00	2,80



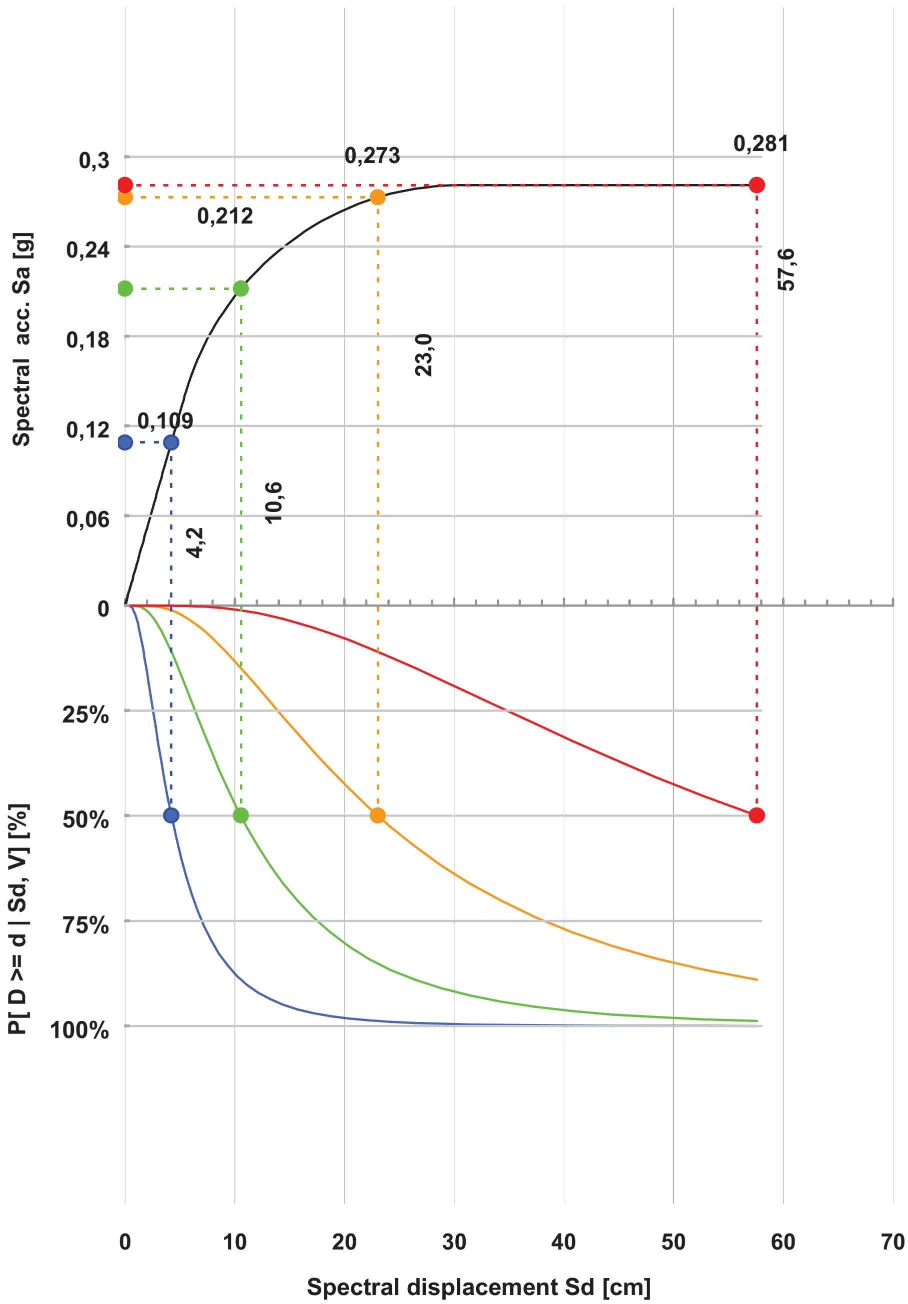
RC 1986-01; No. floors: 5-7

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,30	0,30	0,60	3,28	0,16	3,20	0,20	0,80	0,75	1,50	2,00	5,50
2	0,21	0,85	0,43	9,33	0,12	6,40	0,40	0,80	0,75	1,40	2,00	5,50
3	0,16	1,22	0,33	11,67	0,10	9,60	0,55	0,80	0,75	1,33	2,00	4,80
4	0,16	1,81	0,33	13,05	0,10	12,80	0,67	0,78	0,75	1,30	2,00	3,60
5-7	0,16	2,92	0,32	21,01	0,10	19,20	0,86	0,75	0,75	1,25	2,00	3,60
7-15	0,14	5,45	0,28	30,53	0,09	32,00	1,25	0,70	0,60	1,10	2,00	2,80
>15	0,08	8,20	0,17	45,92	0,05	51,20	2,00	0,70	0,60	1,10	2,00	2,80



RC 1986-01; No. floors: 7-15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,30	0,30	0,60	3,28	0,16	3,20	0,20	0,80	0,75	1,50	2,00	5,50
2	0,21	0,85	0,43	9,33	0,12	6,40	0,40	0,80	0,75	1,40	2,00	5,50
3	0,16	1,22	0,33	11,67	0,10	9,60	0,55	0,80	0,75	1,33	2,00	4,80
4	0,16	1,81	0,33	13,05	0,10	12,80	0,67	0,78	0,75	1,30	2,00	3,60
5-7	0,16	2,92	0,32	21,01	0,10	19,20	0,86	0,75	0,75	1,25	2,00	3,60
7-15	0,14	5,45	0,28	30,53	0,09	32,00	1,25	0,70	0,60	1,10	2,00	2,80
>15	0,08	8,20	0,17	45,92	0,05	51,20	2,00	0,70	0,60	1,10	2,00	2,80



RC 1986-01; No. floors: >15

No.floors	Ay [g]	Dy [cm]	Au [g]	Du [cm]	Cs	H [m]	Te [s]	α_1	α_2	γ	λ	μ
1	0,30	0,30	0,60	3,28	0,16	3,20	0,20	0,80	0,75	1,50	2,00	5,50
2	0,21	0,85	0,43	9,33	0,12	6,40	0,40	0,80	0,75	1,40	2,00	5,50
3	0,16	1,22	0,33	11,67	0,10	9,60	0,55	0,80	0,75	1,33	2,00	4,80
4	0,16	1,81	0,33	13,05	0,10	12,80	0,67	0,78	0,75	1,30	2,00	3,60
5-7	0,16	2,92	0,32	21,01	0,10	19,20	0,86	0,75	0,75	1,25	2,00	3,60
7-15	0,14	5,45	0,28	30,53	0,09	32,00	1,25	0,70	0,60	1,10	2,00	2,80
>15	0,08	8,20	0,17	45,92	0,05	51,20	2,00	0,70	0,60	1,10	2,00	2,80