International Memorial Symposium

"Protecting Lives from Earthquake and Tsunami Disasters"

Tokyo, Japan, June 27, 2012

ブランチャ地震群のための防災国際協力

International Cooperation on Earthquake Disaster Management for Vrancea Seismic Events

R. バカレアヌ ほか ブカレスト工科大学

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同じ震源からの地震に何度も襲われる都市は世界でも例がない

"Nowhere else in the world is a center of population so exposed to earthquakes originating repeatedly from the same source"

C. リヒター 1977年3月
ルーマニア政府宛の書簡

Charles Richter, 15 March 1977,
Letter to the Romanian government

World Map of Natural Hazards prepared by the Münich Re, 1998 indicates for Bucharest: "Large city with Mexico-city effect"

自然災害の世界地図でブカレストは「メキシコ市効果（沼地の埋め立て）のある大都市」

"The unusual nature of the ground motion and the extent and distribution of the structural damage have important bearing on earthquake engineering efforts in the United States."

Jennings & Blume, NRC & EERI Report

通常と異なる地震動特性と構造被害の分布は米国における地震工学上、重要な意義を持つ

ジェニングほか EERI報告書

Seismicity of Vrancea subcustral source (60-180 km) in Carpathian Mountains

ブランチャ震源

1000 yr catalogue of Vrancea earthquakes

ブランチャ地震群のカタログ

• *Major historical events and major earthquakes in the XX century*

Event	Epicentral intensity I_o	Focus depth, km	Moment magnitude M_w	Obs
1802, October 26	> 9		7.9	Largest Vrancea event ever occurred
1829, November 20	≥ 8			
1838, June 23	≥ 8			
1940, November 10	9	150	7.7	
1977, March 4	8/9	109	7.5	Largest seismic losses ever experienced
1986, August 30	7/8	133	7.2	

地震　震央の震度　震源深さ　モーメントマグニチュード　備考

19世紀と20世紀の主な地震

Nov. 10, 1940 earthquake

1940年11月10日の地震

$M_{GR} = 7.4$; $M_w = 7.7$

- At least 350 deaths in Romania
  死者はルーマニア全体で350名以上
- Collapse of **Carlton Building in Bucharest**
  - 11 storey, h = 47 m
  - RC frame
  - 130 death

  ブカレストのカールトンビルの被害
- Important damage in Chisinau, R. of Moldova

March 4, 1977 earthquake

1977年3月4日の地震

$M_w = 7.7$; $h = 109$ km

死者1，578名（うち、ブカレスト市で1，424名）
負傷者11，221名

Killed 1,578 people (1424 in Bucharest)
Injured 11,221 people (7598 in Bucharest)

- Destroyed or seriously damaged 33,000 housing units and caused lesser damage to 182,000 other dwellings
- Destroyed 11 hospitals and damaged 448 others hospitals, etc.

世界銀行による経済的被害

The World Bank estimation of losses (Report 16.P-2240-RO, 1978):

• Total losses in Romania	: 2.05 billion USD	(100%)
Construction losses	: 1.42	(70%)
Building and housing losses	: 1.02	(50%)

1977年地震による教訓
International lessons unlearnt from the 1977 earthquake

1　耐震設計法がつくられる以前の全ての建物の診断をするべきである。

"A systematic evaluation should be made of all buildings in Bucharest erected prior to the adoption of earthquake design requirements and a hazard abatement plan should be developed."

From:

"Observation on the behaviour of buildings in the Romanian earthquake of March 4, 1977" by G. Fattal, E. Simiu and Ch. Cluver. Edited as the NBS Special Publication 490, US Dept of Commerce, National Bureau of Standards, Sept 1977.

2　仮補強の方法を至急、開発すべきである。

"Tentative provisions for consolidation solutions would preferably be developed urgently".

From:

"The Romanian earthquake. Survey report by Survey group of experts and specialists dispatched by the Government of Japan (K. Nakano). Edited by JICA, Japan International Cooperation Agency, June 1977.

3　地震リスクが低い評価のブカレスト市で最も被害が大きかった。

"Bucharest had been microzoned as part of UNESCO Balkan Project, with microzones denoting three levels of risk. The worst destruction occurred in lowest-risk microzone."

From:

"Earthquake in Romania March 4,1977. An Engineering Report" by G. Berg, B. Bolt, M. Sozen, Ch. Rojahn. Edited by National Academy Press, Washington, D.C. 1980

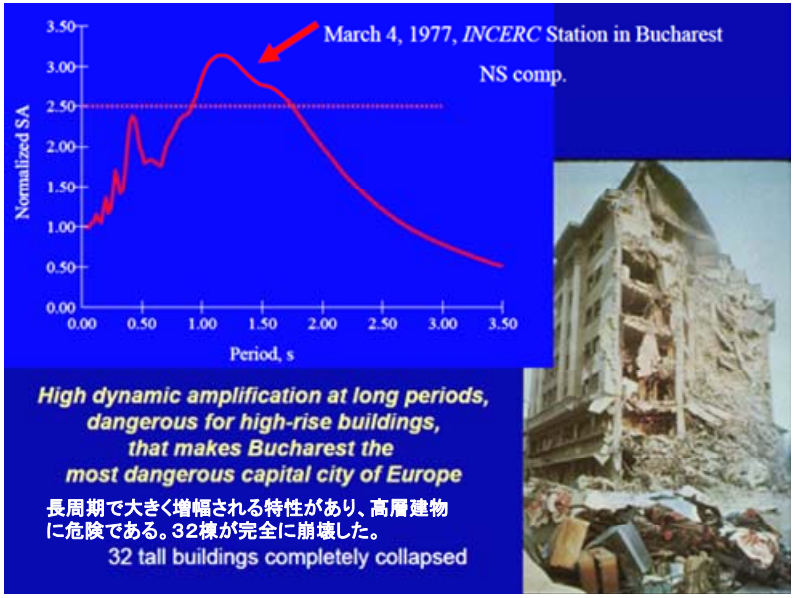
日本の協力でINCERCに設置された強震計で、ルーマニアで最初の記録が取られた。


建築研究資料
Kenchiku Kenkyu Shiryo
No.20 January 1978
ルーマニア地震ディジタル記録
Digitized Data of Strong Motion Earthquake Accelerograms in Romania (March 4, 1977)
強震観測委員会 by Observational Committee of Strong Motion Earthquake
建設省建築研究所
Building Research Institute, Ministry of Construction

March 4, 1977
seismic station INCERC
Bucharest

Station	*Comp.*	*PGA cm/s*	*Tc s*
INCERC O	NS	194.9	1.40s
	Z	105.8	1.20s
	EW	162.3	0.89s

First strong ground motion recorded in Romania

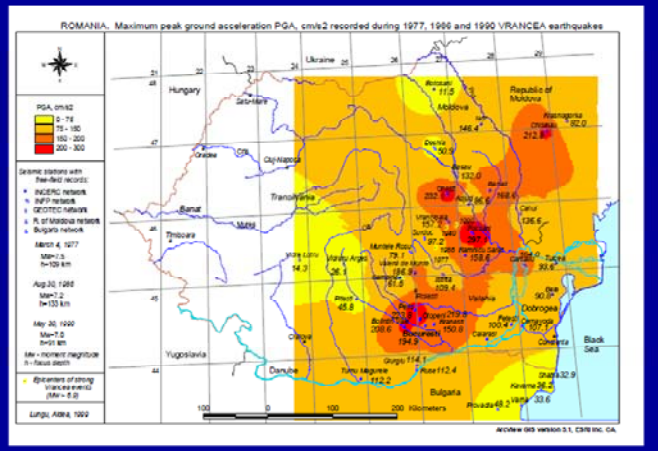


1977年地震時のブカレスト
1977 earthquake in Bucharest

1977 earthquake in Bucharest

1977年地震時のブカレスト

1977, 1986, 1990地震によるルーマニア国内の最大地動加速度の記録
The recorded maximum peak ground acceleration in Romania during 1977, 1986 and 1990 Vrancea earthquakes



世界銀行のレポート
World Bank report

避けうる損失：人命と財産を救うハザード・リスク管理

"Preventable Losses: Saving Lives and Property through Hazard Risk Management"

Strategic Framework for reducing the Social and Economic Impact of Earthquake, Flood and Landslide Hazards in the Europe and Central Asia Region

Draft, May 2004

- ***Romania*** *is regarded as one the most seismically active countries in Europe* ルーマニアはヨーロッパで最も地震活動が活発な国の一つである。
- ***Bucharest*** *is one of the 10 most vulnerable cities in the world.* ブカレストは世界で最も脆弱な10都市の一つである。

ルーマニアに対する推奨
Recommendations for Romania:

- ***Upgrade the legal framework*** *for hazard specific management;* 災害に対する法的基準の整備
- ***Review the existing buildings code*** *for the retrofitting of vulnerable buildings;* 耐震基準の見直しと脆弱建物の補強
- *Conduct a* ***comprehensive public awareness campaign*** *for the earthquake risk;* 地震リスクに対する市民の意識向上
- ***Invest in hazard mitigation*** *activities in order to reduce the risks caused by earthquakes;* 地震災害軽減への投資
- ***Develop financing strategy*** *for catastrophic events.* 甚大な災害に対する経済的戦略の開発

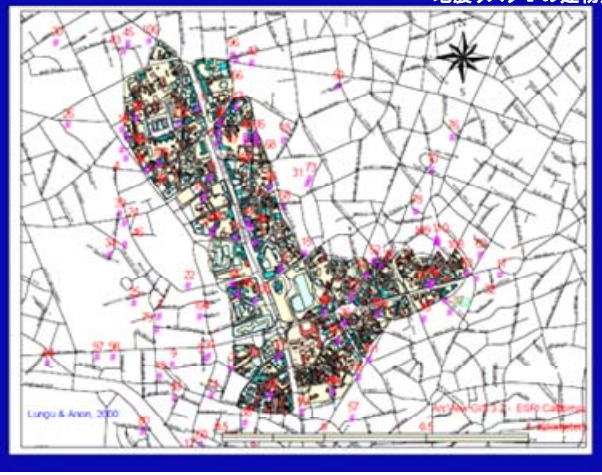
National programs for seismic risk mitigation in Romania
ルーマニア国の地震防災プログラム

Objectives: 目的

- *Strengthening of "seismic risk class I" buildings:* 地震リスクⅠの建物の補強 *Legislation + Construction work*
- *Upgrading of the code for seismic design of buildings and structures* 耐震基準の改善
- *Seismic instrumentation* 地震観測

Central Bucharest: 129 buildings built prior to 1945 and listed as having seismic risk class 1 in case of a strong earthquake, *Mw*≥7.5

ブカレスト中心部における地震リスクⅠの建物分布



Strengthening of 9 storey residential building in central Bucharest 9階建て集合住宅の補強

June 2012, after ≈ 15 yr of actions:

26 buildings are fully retrofitted
out of which
11 were seismic risk class I

26棟が補強済み（そのうち11棟はクラスⅠ）

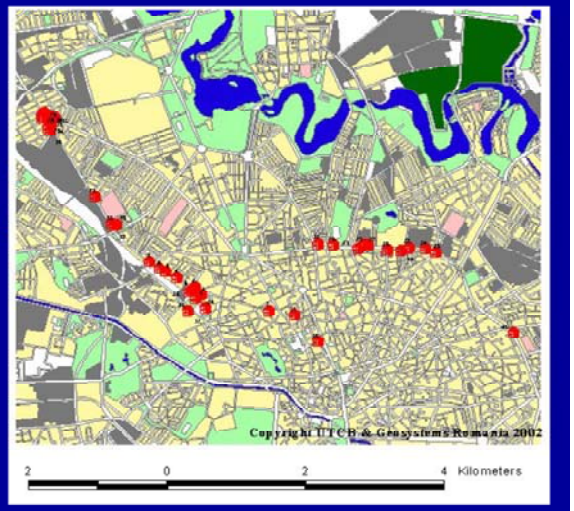
ブカレストの集合住宅の補強
Strengthening of residential buildings in Bucharest

Catogory	No. of. buildings	No. of apartments	Total floor area, m^2
1	26	716	79648
2	111	3189	395738
3	263	2668	366228
4	299	10732	946944
5	69	1590	182622
6	6	86	12530
7	1658	5037	753706
8	147	1522	92122
TOTAL	2579	25540	2829538

1. Retrofitted buildings
2. Seismic risk class I buildings that represent public danger
3. Seismic risk class I buildings
4. Seismic risk class II buildings
5. Seismic risk class III buildings
6. Seismic risk class IV buildings
7. Buildings seismically evaluated according to P100-92
8. Buildings seismically evaluated but not ranked within a seismic risk class.

Fragile tall RC buildings with soft and weak groundfloor, built in Bucharest, 1960-1977

1960－1977
に建設された
軟弱地盤に立つ
脆弱な
高層RC建物



脆弱な7階建てRC建物

Fragile 7-story RC frame building with soft and weak groundfloor, built in '60s, Stefan cel Mare Boulevard

脆弱な7階建てRC建物

Fragile 7-story RC frame building with soft and weak groundfloor, after 1977 seismic event, Stefan cel Mare Boulevard

耐震基準の改善

Upgrading the code for seismic design of buildings and structures

新築に対する耐震基準

*The code for earthquake resistance of **new** buildings,*

P100/1-2006, following EN 1998-1 format, was enforced (Jan 2007)

既存建物の診断補強基準

*The code for seismic evaluation and retrofit of **existing** buildings,*

P100/3-2008, following EN 1998-3 format, was enforced (2008)

新築に対する耐震基準

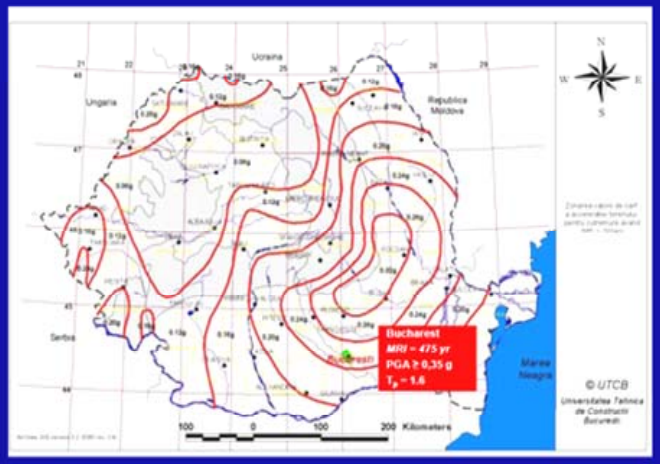
*The code for earthquake resistance of **new** buildings,*

P100/1-2006, is under revision

P100/1-2006基準における地動最大加速度の確率分布

Probabilistic zonation of peak ground acceleration for design

P100/1-2006 Code: *MRI =100 yr*



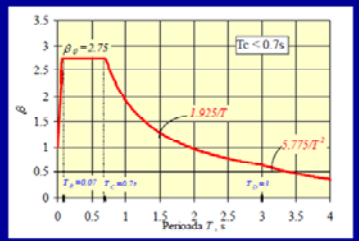
P100/1-2006基準におけるスペクトルのコーナー周期Tcの分布

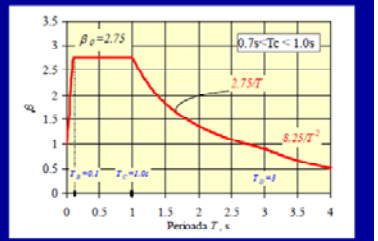
Zonation of control period of response spectrum, T_c

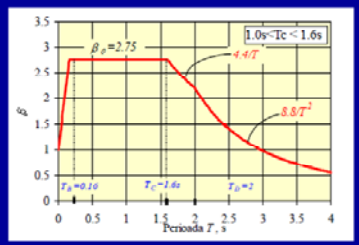
P100/1-2006 Code

Normalised Response Spectra in *EC8* format

P100-1/2006 設計用地震動スペクトル







$T < T_B \qquad \beta = 1 + \frac{(\beta_0 - 1)}{T_B} T$

$T_B < T \le T_C \qquad \beta = \beta_0$

$T_C < T \le T_D \qquad \beta = \beta_0 \frac{T_C}{T}$

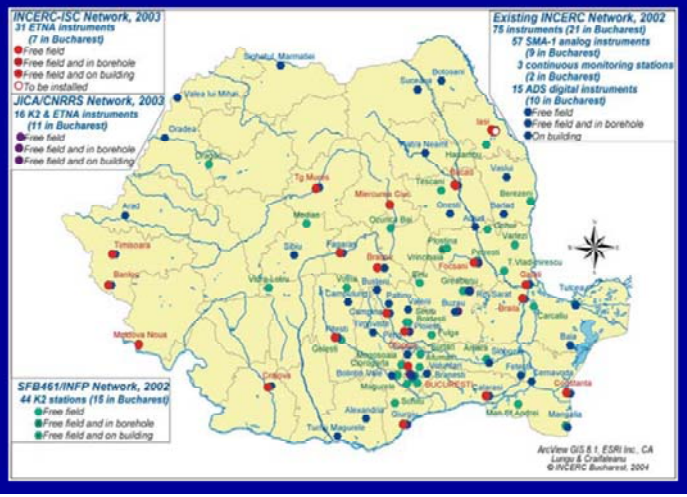
$T > T_D \qquad \beta = \beta_0 \frac{T_C \cdot T_D}{T^2}$

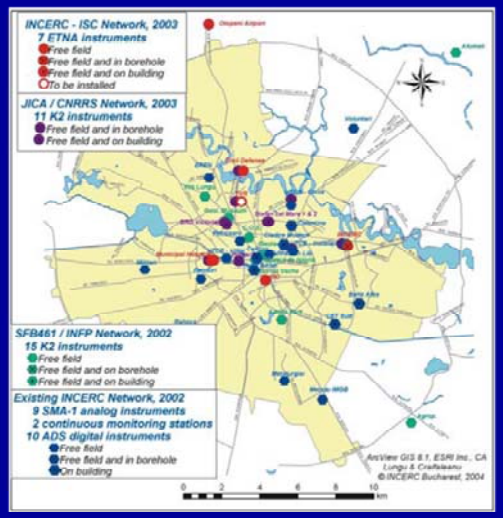
Zonation map of Romania in terms of ground acceleration a_g for seismic events with *MRI* = 225 yr

再現期間225年の最大地動加速度マップ

Romania Seismic networks

地震観測ネットワーク





Bucharest Seismic networks

ブカレスト
地震観測
ネットワーク

地震災害軽減の国際プロジェクト
2. International projects for seismic risk mitigation in Romania

- *JICA Project - Reduction of seismic risk for buildings and structures in Romania*
- *CRC 461 Project – Vrancea Earthquakes. Tectonics, Hazard and Risk Mitigation*
- *RISK-UE - An advanced approach to earthquake risk scenarios with applications to different European town*
- *PROHITECH - Earthquake Protection of Historical Buildings by Reversible Mixed Technologies*
- *World Bank Hazard and risk mitigation in Romania* - Component B: *Earthquake Risk Reduction*
- *NATO Project- Harmonization of Seismic Hazard Risk and Reduction in Countries Influenced by Vrancea Earthquakes*

JICA PROJECT - *Reduction of seismic risk for buildings and structures in Romania*

日本・ルーマニアの外交100周年に、JICAプロジェクトがスタートした。

- *Project signed in 2002, when 100 years of diplomatic relations between Japan and Romania were celebrated*

Partnership of 3 institutions:

ルーマニア公共事業省MDLPLの下の3つの研究機関が協力

NCSRR, National Center for Seismic Risk Reduction

UTCB, Technical University of Civil Engineering Bucharest

INCERC, National Institute for Building Research, Bucharest

under the authority of:

MDLPL, Ministry of Development, Public Works and Housing

- Project duration: 5.5 yr

プロジェクト費用

Total cost of the project

7 mil. USD – Donation from *JICA*

機材供与

- Equipment cost 3 mil. USD:
  - Soil testing laboratory
  - Structure testing laboratory
  - Seismic instrumentation network in Bucharest and Romania (free field, borehole, buildings)

研修・専門家派遣

- 29 Romanian young students/engineer trained in Japan
- 46 Japanese short term and long term experts in Romania

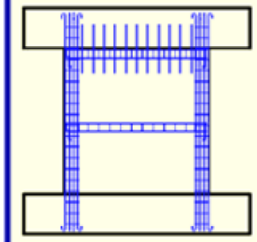
Structural testing equipment - Reaction frame

日本が供与した構造実験施設

- ✓Maximum weight of tested specimens - 7t
- ✓Maximum dimensions of the tested specimens - 2.5m by 3 m
- ✓Reaction frame 9.7m x 7.6m

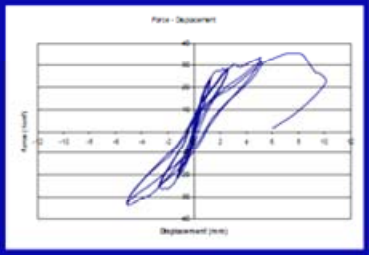
JICA Project – structural testing

JICAプロジェクトによる構造実験

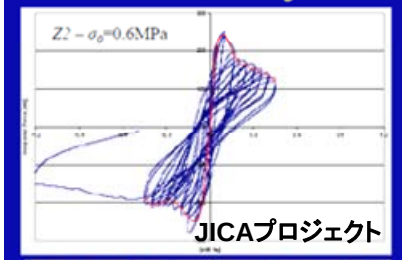


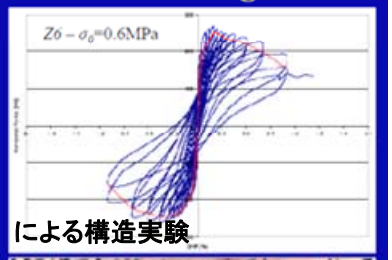
Specimen	σ_0	Armare "grinda"	Armare "stalp"	Armare inima	Mod de cedare
W1	0.13	da	sporita	-	Forta taietoare
W2	0.26	da	sporita	-	Forta taietoare
W3	0.13	-	sporita	-	Forta taietoare
W4	0.13	da	normala	-	Incovoiere
W5	0.13	da	normala	da	Incovoiere

W1

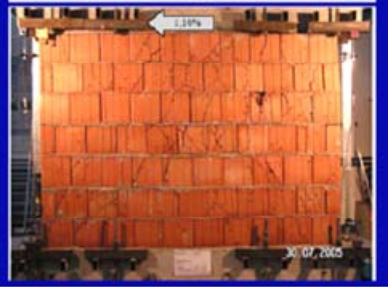


JICA Project – structural testing





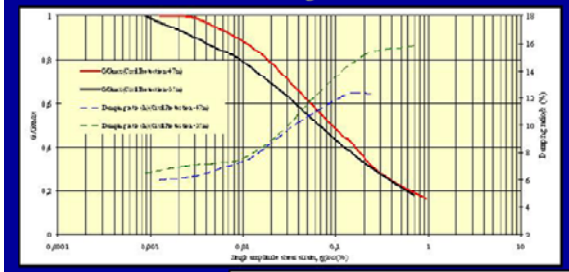
JICAプロジェクト　による構造実験



Equipments for soil investigation
Triaxial testing equipment　3軸土質試験機

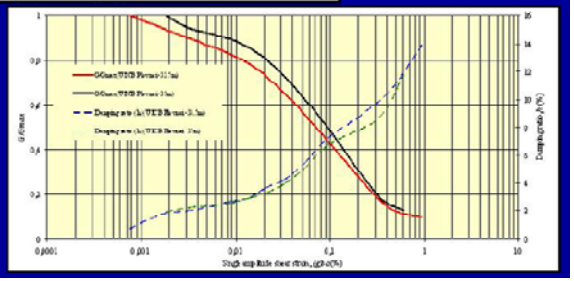
JICA Project – soil investigation

土質試験の結果



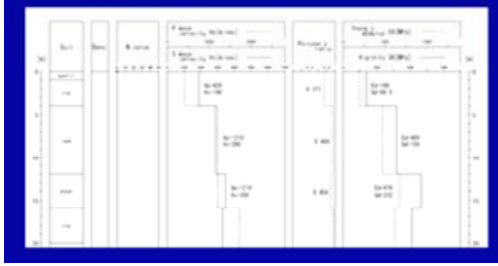
Results from triaxial testing equipment for *Civil Protection* site

Results from triaxial testing equipment for *UTCB Plevnei* site



PS logging, downhole method results
PS検層による地盤調査

Adamówka forag. nr	Site	$V_{s,30}$	T_g	$V_{s,51}$	T_g
140	INCERC	271	0.449	301	0.677
69	SPITAL	246	0.495	279	0.731
110	Victoriei	285	0.427	309	0.660
78	UTCB	310	0.393	325	0.627
66	INSTALATII	289	0.421	317	0.643
68	PRC	294	0.414	308	0.662
51	Primarie	224	0.544	264	0.772



JICAプロジェクト　地震観測ネットワーク

JICA Project – seismic network

✓*ETNA-Kinemetrics* and *Geosig* accelerometers (3 channels) - placed in free field outside Bucharest

✓*ALTUS K2-Kinemetrics* and *Geosig* accelerometers (12 channels) – installed in boreholes and buildings inside Bucharest

Seismic network

Free field	Borehole	Building
outside Bucharest	Bucharest	Bucharest
ETNA & Geo	*K2&Geo*	*K2&Geo*
8 sites	8 sites	5 sites
6 - JICA	7 - JICA	4 - JICA
2 - MTCT	1 - MTCT	1 - MTCT
地表	地中	建物内

典型的なRC構造の共同住宅

Typical RC
frame structure
residential
Buildings
1 - after 1977 (11 storeys)
2 - before 1977 (7 storeys)

National Romanian Television.
RC frame structure built before
1977 earthquake
(14 storeys)

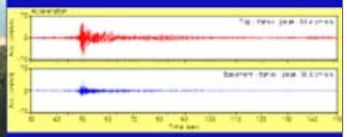
国営ルーマニアテレビ
1977年地震以前のRC構造14階

ソシエテジェネラル銀行本部
2002年のRC造　19階

BRD - Société Générale
bank headquarters

RC structure, 2002

19 storeys

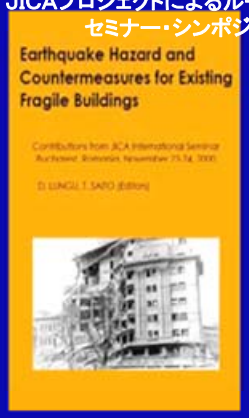


27 October, 2004 seismic event

2004年10月27日の強震記録

JICA Project for Seismic Risk Reduction in Romania

JICAプロジェクトによるルーマニアの防災セミナー・シンポジウムの報告書



JICA International Seminar, Bucharest, Nov. 23-24, 2000

International Symposium on Seismic Risk Reduction – The JICA Technical Cooperation Project, Bucharest, April 26-27, 2007

JICA Project for Seismic Risk Reduction in Romania

JICAプロジェクトが終了後、2010年8月にルーマニア政府は地震防災センターを解体し、機材をINCERCに移した。センター・スタッフの多くは大学（UTCB)に戻った。

Even the *NCSRR* was created for building a capacity to last even after the termination of *JICA* Project in Romania, in August 2010 the Romanian authorities decided to dismantle the *Center* and to relocate the equipments to the former partner, *INCERC*. The whole staff of *NCSRR* from *UTCB* (almost 90% of the staff of *NCSRR*) stayed with the University.

It is like a computer with the software (highly trained engineers) in one place and the hardware (equipment) in some other place – not operational.

これはコンピュータで例えれば、ソフト（人材）とハード（機材）を別の場所に分けたことになり、機能しない。

ドイツ・カールスルーエ大学との共同研究

***CRC 461, Collaborative Research Center* - Strong Earthquakes: A Challenge for Geosciences and Civil Engineering**

University of Karlsruhe, Germany

1996年から2007年まで

Starting Date: 1996
Ending Date: 2007

Future
Extension of seismic cooperation
?

参加者
Participants

- *Collaborative Research Center (CRC) 461*: "Strong Earthquakes: A Challenge for Geosciences and Civil Engineering", University of Karlsruhe, Germany

and

- *Romanian Group for Strong Vrancea Earthquakes (RGVE)*
  - ***INFP,*** *National Institute for Earth Physics*
  - ***UTCB,*** *Technical University of Civil Engineering*
  - ***INCERC****, National Institute for Building Research*
  - ***University of Bucharest,*** *Faculty of Geology and Geophysics*
  - ***GEOTEC,*** *Institute for Geotechnical and Geophysical Studies*

  and others

Project planning プロジェクト計画

- **A I:** *Deep Seismic Sounding of the Vrancea Zone*
- **A 6:** *Stress Field and Geodynamics*
- **A 7:** *Strong Ground Motion Assessment*
- **B 1:** *Three-Dimensional Plate Kinematics in Romania*
- **B 3:** *Seismogenic Potential of the Vrancea Subduction Zone - Quantification of Source- and Site-Effects from Strong Earthquakes*
- **B 4:** *Non-Linear Wave Phenomena in Fine and Soft Soils*
- **B 6:** *Geotechnical and Seismic Microzoning of Bucharest*
- **B 7:** *Hydrogeology and Site Effects by Earthquakes in Bucharest*
- **C 2:** *Methods for the Retrofitting of Damaged Buildings*
- **C 3:** *Disaster Management - Models and Simulation*
- **C 5:** *Image Analysis in Geosciences and Civil Engineering*
- **C 6:** *Knowledge Representation for Disasters with a Technical Information System*
- **C 7:** *Novel Rescue and Restoration Technologies*
- **C 9:** *Vulnerability Analysis of Existing Structures*
- **Z 1:** *Central Geographical Information System (GIS)*
- **Z 2:** *SFB Management*

ルーマニアUTCB大学とドイツKarlsruhe大学では、地震計をブカレスト市内に密に配置することにした。

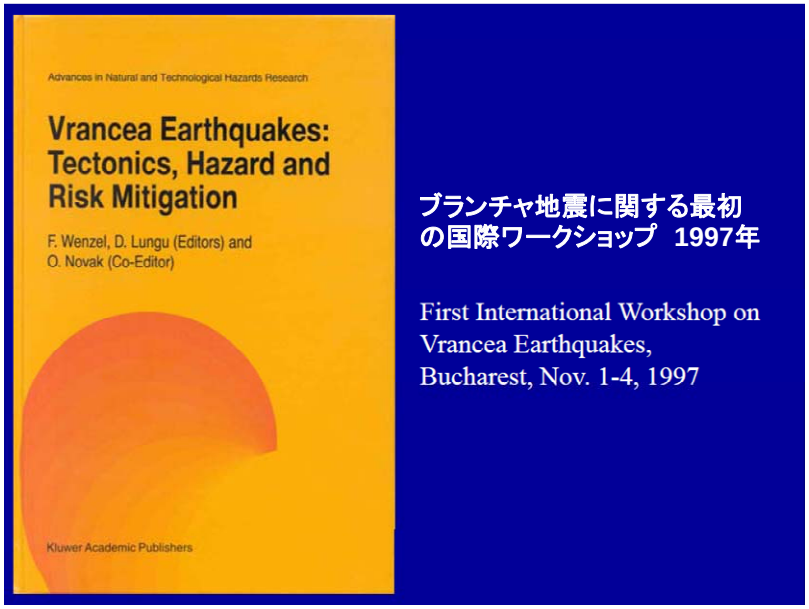
The contribution of engineers from RC departments in both UTCB & Univ. of Karlsruhe to the CRC461 seismic instrumentation project in Romania was focusing on conversion of the original pattern of CRC461 instrumentation initially planned outside Bucharest into finally dense seismic instrumentation inside Bucharest.

That new pattern of the CRC461 network in Bucharest was the basis for the future microzonation studies as well as for dynamic characterization of site conditions in the capital city of Romania.

CRC361地震観測ネットワークは、首都ブカレストの将来の地震マイクロゾーニング研究の基礎となる。

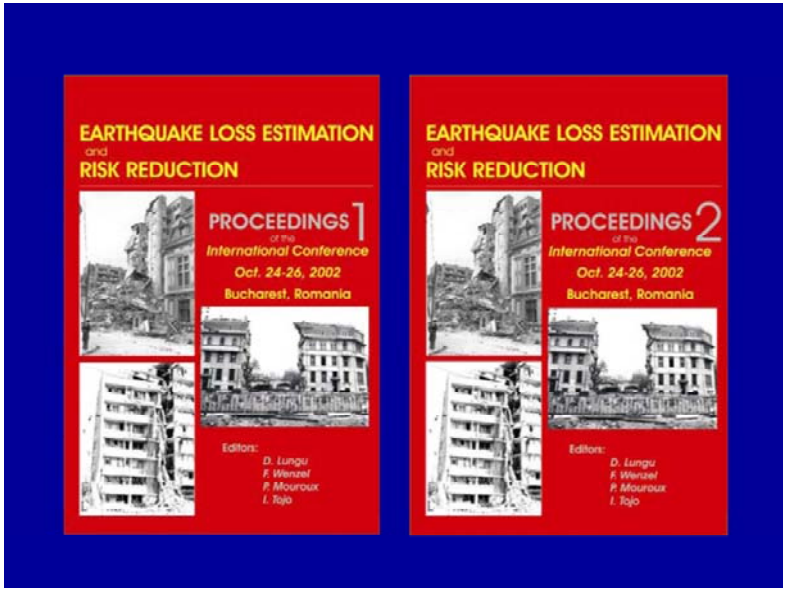
Test building at INCERC site and ALGA rubber bearings HDRB 250x164.5

免震装置



ブランチャ地震に関する最初の国際ワークショップ　1997年

First International Workshop on Vrancea Earthquakes, Bucharest, Nov. 1-4, 1997



RISK-UE - An advanced approach to earthquake risk scenarios with applications to different European towns

RISK-UE　ヨーロッパの異なる都市の地震リスクシナリオ研究

Contract n° EVK4-CT-2000-00014 with European Commission, Research Directorate General

2001年から2004年まで計2,477,643ユーロ

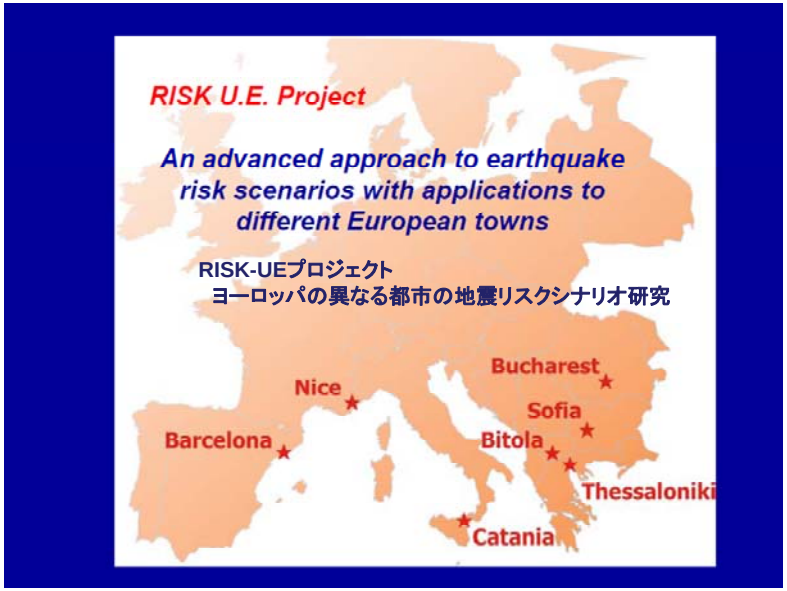
Amount: 2 477 643 €

Funding: EC : 66 %

participants: 34 %

Starting Date: 2001

Ending Date: 2004



Project planning
プロジェクト計画

WP 1: *Evaluation of European distinctive features*

WP 2: *Earthquake hazard assessment*

WP 3: *Urban system analysis*

WP 4: *Vulnerability assessment of current buildings*

WP 5: *Vulnerability assessment of historical and monumental buildings*

WP 6: *Vulnerability assessment of lifelines and essential structures*

WP 7: *Earthquake risk scenarios*

参加機関
Participants

Name Participants	Responsible person
Bureau de Recherches Géologiques et Minières, BRGM, France	P. Mouroux Project Co-ordinator
Géologie tectonique environnement et risques, France	C. Martin
Politecnico di Milano, POLIMI, Italy	E. Faccioli
University of Genoa, UNIGE, Italy	S. Lagomarsino
Technical University of Civil Engineering, UTCB, Romania	D. Lungu
Institut Cartografic de Catalunya, ICC, Spain	A. Roca
Aristotle University of Thessaloniki, AUTH, Greece	K. Pitilakis
Institute of Earthquake Engineering and Engineering Seismology, IZIIS, FYROM Macedonia	Z. Milutinovic
Central Laboratory for Seismic Mechanics and Earthquake Engineering, CLSMEE, Bulgaria	M. Kostov

Workpackage 1 of **RISK-UE**

European distinctive features, inventory database and typology

Objective 1 - Distinctive features of European towns

- Town identity　　目的1： ヨーロッパ諸都市の特徴
- Population characteristics
- Urbanised area and elements at risk
- Impact of past earthquakes on elements at risk
- Strong motion data in the city and seismic hazard
- Geological, geophysical and geotechnical information
- Evolution of earthquake resistant design codes
- Earthquake risk management efforts

References

Objective 2 - Europe inventory database and typology
目的2： ヨーロッパ諸都市の建物情報の整理

Classification of buildings occupancy

Code	Occupancy category	Importance & exposure category		
		1	2	3
B	*GENERAL BUILDING STOCK*			
B1	*Residential*			
1.1	Single family dwelling (house)			x
1.2	Multi family dwelling (apartment bldg.)			
1.3	Low-rise (1-2)			x
1.4	Mid-rise (3-7)			x
1.5	High-rise (8+)		x[2]	x
1.6	Institutional dormitory		x[1]	x
B2	*Commercial*			
2.1	Supermarkets, Malls		x[2]	x
2.2	Offices		x[2]	x
2.3	Services			x
2.4	Hotels, Motels		x[2]	x
2.5	Restaurants, Bars			x
2.6	Parking			x
2.7	Warehouse			x
B3	*Cultural*			
3.1	Museums		x[2]	x
3.2	Theatres, Cinemas		x[2]	x
3.3	Public event buildings		x[2]	x
3.4	Stadiums		x[2]	x

1) Buildings with capacity greater than 150 people
2) Buildings with capacity greater than 300 people or where more than 300 people congregate in one area

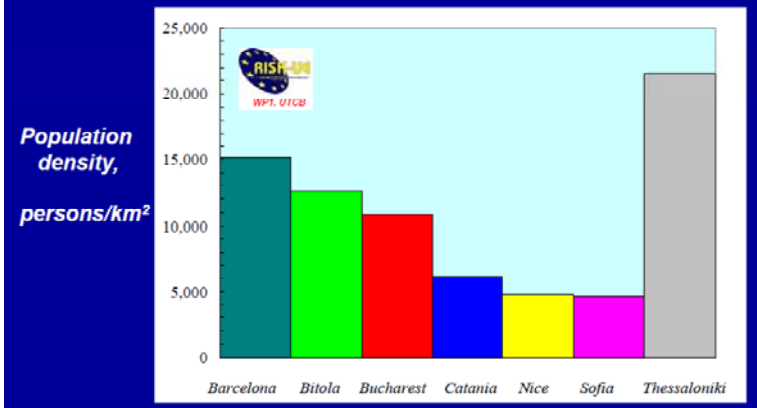
Building typology matrix, *BTM* 建物タイプ

Label	Building type description	Height description: Name	Height description: No. of stories	Height description: Height h, m	Code level* N	L	M	H
RC	*Reinforced concrete structures*							
RC1	Concrete moment frames	Low-rise Mid-rise High-rise	1 - 3 4 - 7 8+	h ≤ 9 9 < h ≤ 21 h > 21				
RC2	Concrete shear walls	Low-rise Mid-rise High-rise	1 - 3 4 - 7 8+	h ≤ 9 9 < h ≤ 21 h > 21				
RC3	Concrete frames with unreinforced masonry infill walls							
3.1	Regularly infilled frames	Low-rise Mid-rise High-rise	1 - 3 4 - 7 8+	h ≤ 9 9 < h ≤ 21 h > 21				
3.2	Irregularly frames (i.e., irregular structural system, irregular infills, soft/weak story)	Low-rise Mid-rise High-rise	1 - 3 4 - 7 8+	h ≤ 9 9 < h ≤ 21 h > 21				
RC4	RC Dual systems (RC frames and walls)	Low-rise Mid-rise High-rise	1 - 3 4 - 7 8+	h ≤ 9 9 < h ≤ 21 h > 21				
RC5	Precast Concrete Tilt-Up Walls	Low-rise Mid-rise High-rise	1 - 3 4 - 7 8+	h ≤ 9 9 < h ≤ 21 h > 21				
RC6	Precast Concrete Frames with Concrete shear walls	Low-rise Mid-rise High-rise	1 - 3 4 - 7 8+	h ≤ 9 9 < h ≤ 21 h > 21				

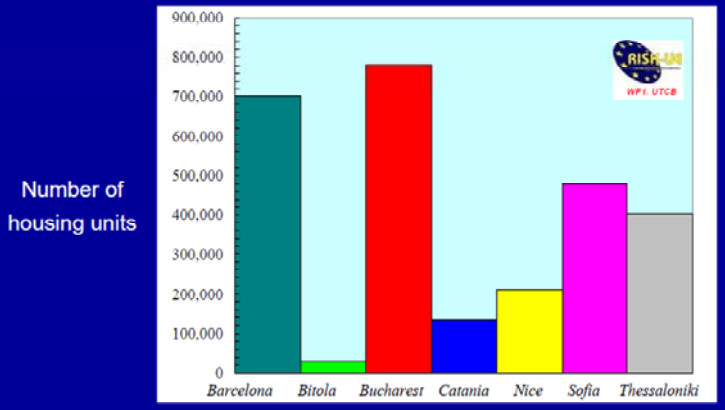
*Code level

N - no code;
L - low-code (designed with unique arbitrary base shear seismic coefficient);
M - moderate-code;
H - high-code (code comparable with Eurocode 8)

Population density in the 7 towns
7都市の人口密度



Number of housing units for 7 towns
7都市の住宅数



ヨーロッパの建物ストックの脆弱性とタイプ
Vulnerability and typology of European buildings stock

Building stock age in the 7 towns versus Seismic codes inter-benchmark periods

7都市の建物の耐震設計の時期とその分布

Town	Seismic codes inter-benchmark periods: Pre-code	Low-code	Moderate code
Barcelona	*79%*	*21%*	*--*
Bitola	*48%*	*29%*	*23%*
Bucharest	*30%*	*30%*	*40%*
Catania	*92%*	*-*	*8%*
Nice	*75%*		*25%*
Sofia	*Data not available*		
Thessaloniki	*20%*	*50%*	*30%*

PROHITECH

歴史建物の地震からの保護に関わるプロジェクト

PROHITECH - Earthquake Protection of Historical Buildings by Reversible Mixed Technologies

Contract nº INCO – CT-2004 - 509119 with European Commission, Research Directorate General

2004年から2007年まで計2,400,000ユーロ

Amount: 2 400 000€

Funding: EC: 88 %,

participants : 12 %

Starting Date: 2004

Ending Date: 2007

プロジェクト計画
Project planning

WP 1: *Overview of existing techniques*
WP 2: *Damage assessment*
WP 3: *Risk Analysis*
WP 4: *Intervention strategies*
WP 5: *Innovative materials and techniques*
WP 6: *Reversible mixed technologies*
WP 7: *Experimental analysis*
WP 8: *Numerical analyses*
WP 9: *Calculation models*
WP 10: *Validation of innovative solutions and procedures*
WP 11: *Study cases*
WP 12: *Design guidelines*

参加機関
Participants

Partic. no.	Institution name	Country	Responsible person
1	UNIVERSITY OF NAPLES FEDERICO II - ENGINEERING	Italy	F. Mazzolani, Project Co-ordinator
2	UNIVERSITY OF LIÈGE	Belgium	J.-P. Jaspart
3	UNIVERSITY "SIS. CYRIL AND METHODIUS" OF SKOPJE	FYR Macedonia	K. Gramatikov
4	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	Greece	I. Vayas
5	UNIVERSITY OF NAPLES FEDERICO II - ARCHITECTURE	Italy	F. Laviola
6	INSTITUTO SUPERIOR TÉCNICO OF LISBON	Portugal	L. Calado
7	THE " POLITEHNICA " UNIVERSITY OF TIMIŞOARA	Romania	D. Dubina
8	TECHNICAL UNIVERSITY OF CIVIL ENGINEERING - BUCHAREST	Romania	D. Lungu
9	UNIVERSITY OF LJUBLJANA	Slovenia	D. Beg
10	BOĞAZİÇİ UNIVERSITY	Turkey	C. Altay
11	TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY, HAIFA	Israel	A. V. Rutenberg
12	ENGINEERING CENTER FOR ARCHAEOLOGY AND ENVIRONMENT (ECAE) – FACULTY OF ENGINEERING - CAIRO UNIVERSITY	Egypt	M. El Gohbi
13	NATIONAL SCIENTIFIC AND TECHNICAL RESEARCH CENTRE	Morocco	A. Ibrahim
14	SECOND UNIVERSITY OF NAPLES	Italy	A. Mandara
15	FACULTE DE GENIE CIVIL, UNIVERSITE DES SCIENCES ET DE LA TECHNOLOGIE, (USTHB) ALGIERS	Algeria	M. Chemrouk
16	UNIVERSITY OF CHIETI/PESCARA	Italy	G. De Matteis

世界銀行によるプロジェクト
World Bank Project in Romania

Component A: 防災マネジメントの強化

Strengthening of disaster management capacity

Component B: 地震リスクの軽減

Earthquake Risk Reduction - 71.2 million US$

Subcomponents: 補強、検査、設計法の改善、補強のための研修

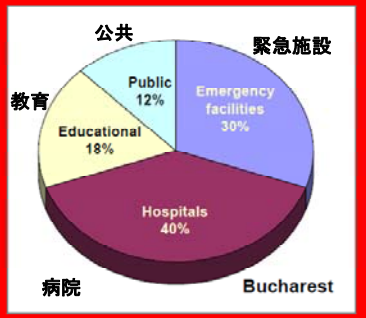
- ***Strengthening of high priority buildings and lifelines***
- ***Design & supervision***
- ***Building code review and study of code enforcement***
- ***Professional training in cost effective retrofitting***

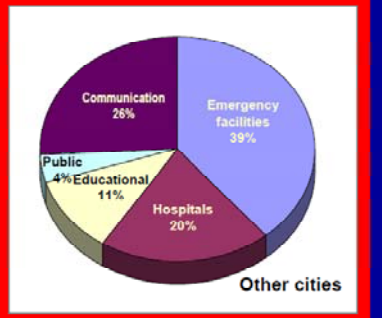
Components C, D&E: ***Flood, Pollution & Project Management***

洪水、公害対策

Distribution of buildings with occupancy

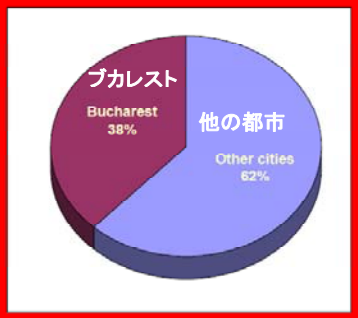
対象建物の分布 （左:ブカレスト、右:他都市）





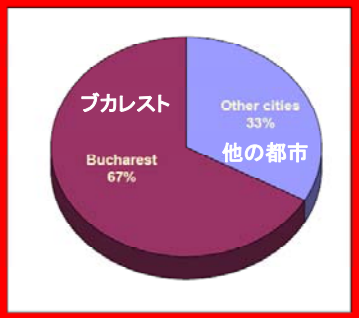
Distribution of number of buildings to be retrofitted

補強が必要な建物の比率



Distribution of cost for buildings to be retrofitted

補強に必要なコストの比率



Conclusions

結　論

Impediments in Earthquake Disaster Management

地震災害マネジメントの障害

1. Weak political support – results pay off later 弱い政治サポート
2. Low public awareness – time between earthquakes longer than the vivid memories of the public – as consequences:
   - Disaster relief – OK
   - Preparedness – low

   低い防災意識
   結果として、地震前の準備よりも地震後の対応に関心
3. Retrofitting of residential buildings – hard process because of social issues: multiple owners, lack of awareness, poverty, juridical issues on property
   集合住宅の補強の難しさ
   区分所有、低い防災意識
4. International financing bodies of retrofitting programs – focus on public buildings and structures

   国際資金は公共建物の補強に重点がある（民間の集合住宅の補強がおろそかになる）

Conclusions

Further actions 将来の課題

1. Prepare and endorse a manual for post-earthquake investigation to be used within IPRED missions; manual shall include very clear rules and very precise criteria for making the decision on the damage state of the buildings
   建物の地震後の診断マニュアル
2. The post-earthquake investigation information on the damage on buildings, structures and lifelines shall be valuable in two directions:
   建物の地震後の診断の重要性
   - lessons learnt on the vulnerability of different building typologies and/or construction techniques and details; this information shall be used to improve the seismic design regulations;
     耐震基準の改善において重要
   - statistical information for different building typologies and different seismic demands; this information might be used for both seismic design regulations and for fragility/vulnerability and risk analysis.