ANNEX VIII

PROJECT DOCUMENT

THE PROJECT ON THE REDUCTION OF SEISMIC RISK FOR BUILDINGS AND STRUCTURES IN ROMANIA

AUGUST 2002

MINISTRY OF PUBLIC WORKS, TRANSPORT AND HOUSING (MLPTL)

AND

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Contents

1. Introduction

Romania is a country in Europe that is notorious for earthquakes. In particular, earthquake damage has been concentrated in the capital city, Bucharest. In its history it has often been prone to damage by great earthquakes.

On March 4, 1977, an earthquake of moment magnitude 7.5 occurred in Vrancea county. At this time, most of the damage was concentrated in Bucharest. It was recorded that 1,578 people (1,424 people in Bucharest) were killed and the cost of the damage was 3 billion dollars (2 billion dollars in Bucharest). Moreover, 1.4 billion dollars of this sum, which was 70 percent of the total losses caused in Bucharest, were caused by building collapse.

Seismologists are forecasting that another earthquake of the same magnitude as the great earthquake of 1977 will occur around 2007 (30 years after the last great earthquake), this prediction is based on the assumption that the recurrence period of the earthquake similar to that one in 1977 is said to be 30 years. The Romanian government considers it important to retrofit fragile buildings that might collapse due to the predicted earthquake in Bucharest. If the recent action for retrofitting the buildings by the Romanian government is looked at, following a government ordinance, buildings were classified (I-IV) according to the seismic risk level, and 110 buildings (more five buildings were added in August, 2001, making 115 buildings at present) in Bucharest were recognized as Class I (most susceptible to be damaged by earthquake). In regard to these buildings, a more detailed inspection was implemented. After seeing the results, MLPTL declared its intention to gradually put the retrofitting scheme for the 115 buildings into practice. However, there are no cost/time effective retrofit techniques available in Romania. Also, as the basic data for grounding proper seismic design have not been accumulated/ analyzed in depth, the appropriate seismic design method, which is prepared based on the data, has not been developed.

Just after the 1977 Vrancea earthquake JICA dispatched a study team, consisting of earthquake-related experts. The team gave some technical guidance concerning possible seismic countermeasures to the Romanians. However, after the official technical aid by the Japanese Government was completed, no other activities were followed.

In August 1998, when the liberalization on society and economy had progressed in Romania, the Romanian government requested the Japanese Government to dispatch some experts of earthquake engineering . It was at that time that the official contact with Romania and Japan in the field of earthquake disaster prevention restarted first time in 21 years since the previous official cooperation had ended. Responding to this request, the Japanese Government dispatched two short-term experts (September, 1999), started a training program for Romanian earthquake engineer trainees (1999-), and dispatched a long-term (two years) expert (March, 2000-).

Earthquake is a natural disaster, which cannot be controlled by human. However, earthquake damage can be mitigated by application of appropriate technology. In this Project, the main emphasis of technology transfer is in the field of earthquake engineering. The aim of the Project, therefore, is through cooperation to improve the quality of earthquake disaster prevention technology in Romania, specifically to reduce the likelihood of buildings collapse or severe damage by earthquakes. The main target group in this Project is defined as being the residents of Bucharest. The reasons for this focus are as follows: the expected Project term is 5years; previous earthquakes have had the most impact in Bucharest, and Bucharest is the capital city and politically and economically the most important city.

This project document was prepared not only for Japanese experts and their Romanian counterparts but the third parties who will play the main role in the Project implementation stage. It was so compiled as for insiders concerned with the Projectst to share the same level of understanding and for outsiders to be briefed the series of processes through which the Project was planned, how the related problems were analyzed and how strategies were established.

2 Background of the Project

2-1. Socio-economic context

2-1-1. Political trends

After the reign of Ceausescu ended in December 1989, the National Salvation Front political power was established. Its leader was Iliescu, a former leader of the communist party. A new constitution was promulgated in December 1991.

In September 1992 general presidential elections were held, and the system of Iliescu was allowed to continue. However, in the subsequent general elections of 1996, the Democratic Convention won the election, and a new political system with new policies began, with Emil Constantinescu installed as the second president. The new political system aimed to rebuild the country through economic reform and the complete liberalization of prices and exchange rate. It also desired to join both the EU and NATO.

In the general election of November 2000, the current political system in which Nastase, the PDSR party leader become the prime minister, was established. More information on the current regime and its activities can be found later in this document (References 7:p.4).

2-1-2. Economic trends

Romania has a population of 22.4 million. It has the second largest land space of the Central Eastern European countries after Poland. It also has some industrial infrastructure and fertile earth (black soil which is called chernozem) Romania produces about 6 million tons of crude oil , which fulfills half of domestic demand, 4 million tons of wheat even in a bad harvest season, which completely fulfills domestic demand, as well as 100,000 passenger cars each year.

After the World War II, the economic system shifted from an agricultural economy to a planned economy under the communism system. At the time of the 1989 Revolution, the country had been disrupted by an inefficiently planned economy and the superannuation of equipment and facilities while being hampered by slowly progressing technology. After the Revolution, however, a market economy system was introduced to aid the development of the reformed country. This meant that some subsidy systems were abolished, prices were liberalized, exchange rate was partly liberalized and value added tax was introduced; etc. Unfortunately these measures also brought economic deceleration and hyperinflation (about 300 percent in 1993).

Industrial production had recovered somewhat by 1994. Together with the reduction of the budget deficit, a tight-financing and monetary policy, complete liberalization of exchange rate with the decrease and withdrawal of various subsidies, etc. were introduced. Is spite of these reforms, hyperinflation reemerged in 1996; the inflation rate reaching 151.4 percent in1997 and GDP decreased 6.6 percent. A similar situation continued in both 1998 and 1999, where the inflation rate became about 40-50 percent and GDP growth rate continued to be very poor at-7.3 percent (1998) and -3.2 percent (1998).

In the year 2000, the Government began to manage the political situation with the target that the ratio to GDP to fiscal deficit should be 3 percent; the inflation rate should be 27 percent and the economic growth rate should be plus 1.3 percent. However, in fact, the inflation rate had reached 40.7 percent and the budget deficit had reached 3.7 percent. However, while Macroeconomic conditions had not been stabilized, industrial production had recovered; export conditions were improved and GDP growth rate of 1.6 percent was achieved. The Government forecasted the economic growth of 2001 as 4.1-4.5 percent (References7: p13).

Table 1. Main Economic Indicators

Item	Unit	1992	1993	1994	1995	1996	1997	1998	1999	2000
Population	1,000,000 people	22.8	22.8	22.7	22.7	22.6	22.5	22.5	22.5	22.4
GDP per person	Dollar	859	1,159	1,324	1,537	-	-	1,390	1,470	1,515
GDP growth rate	%	-8.8	1.5	3.9	7.1	3.9	-6.6	-7.3	-3.2	1.6
Inflation rate	%	199.2	295.5	61.7	27.8	56.9	151.4	40.6	54.8	40.7
Unemployment rate (end of the year)	%	7.4	9.5	9.5	7.4	6.1	8.8	10.3	11.5	10.5
Exchange rate (annual average)	lei/dollar	308.0	760.0	1,655.1	2,033.3	3,082.6	7,167	8,876	15,333	21,693
External debt	Billion dollar	2.4	3.3	4.9	5.3	7.1	8.2	9.0	8.6	10.2

Source (GDP per person: IMF, Exchange rate and External debt: Romania Central Bank, Other items: Romania National Statistics Bureau)

2-2. Description of the sector

2-2-1. Seismic characteristics of Romania

Earthquakes in Romania are roughly categorized into two types: crustal and sub-crustal types. Generally, crustal earthquakes, the epicenters of which are shallower, occur all over Romania. The magnitude and damage caused by these earthquakes are small, and large-scale damage by crustal earthquake has not been reported. On the other hand, the occurrence and features of sub-crustal earthquakes, the epicenters of which are deeper, are concentrated in the Vrancea province where the arch of the Carpatii mountain range bends greatly. Sub-crustal earthquakes have frequently occurred in this region with large-scale magnitudes. The damage caused by these types of earthquake is seen not only in Romania but also in other neighboring countries (refer to 7-7-1).

In regard to the earthquakes in Vrancea county where the seismic sources are located, it is elucidated that the earthquake frequently occurs within a limited area of about 40km width and 80km length, with a depth of about 70km to 200km. However, mechanism how earthquakes occur is not analyzed fully although there are various theories (Reference 5: page E-1 and 2).

Although it cannot be said for certain, seismologists predict that a great earthquake will occur around 2007. This is predicted by referring to past earthquake records, in which the recurrence period of a great earthquake is 30 years with the similar scale of the last great earthquake occurred in 1977.

2-2-2. Vrancea Earthquakes damage in Bucharest

As explained in the Introduction, Bucharest has been subjected many times to damage by great earthquakes (Vrancea earthquakes). If the past damage records are looked at, the damage caused by main earthquakes are as described in Table 2.

Table 2. The Scale and damage of large earthquakes, which attacked the Bucharest area

Date	Magnitude	Reported damage
August 19, 1681	7.1	It was reported that the, "Ground shook so that it was not possible to stand".
June 11, 1738	7.7	Some towers/ walls in Bucharest Palace were destroyed.
October 26, 1802	7.9	All church towers in Bucharest and many dwellings collapsed.
November 23, 1829	7.3	150 houses collapsed.
November 10, 1940	7.7	Many buildings collapsed. 267 people were killed.
March 4, 1977	7.5	35 of 7-14 story buildings collapsed. 1,570 people were killed.
August 30, 1986	7.2	2 people were killed, 558 were injured, and 55,000 buildings were damaged.
May 30, 1990	6.9	9 people were killed and 700 people were injured.

(References 5: page E-4)

In particular, the earthquakes that occurred in 1940 and 1977 caused large-scale damage, and the scale of the damage caused by the 1977 earthquake was the biggest in the history of Romania. According to the World Bank report issued in 1978, it was reported that this earthquake killed 1,578 people. The total estimated economic loss was about 3 billion dollars, with 1,424 people being killed in Bucharest, with the cost to the capital of about 2 billion dollars. It can easily be seen therefore that most of the damage was concentrated in Bucharest. Moreover, it was reported that the loss of 1.4 billion dollars, which was 70 percent of total loss in Bucharest, was due to building collapses.

Still now Bucharest contains many buildings, which were constructed before 1940 and have already been weakened by two great earthquakes. Obviously, these old and weakened buildings are under considerable threat of collapse in a future great earthquake. As the capital of Romania, Bucharest functions not only as a center of politics, economy, culture, and transport, but also as the main population center which is home to 2,010,000 people (References 9) accounting for about 9 percent of the countries residents. It is therefore vital to defend Bucharest from earthquakes, for not only economic but also humanitarian reasons.

2-2-3. Current countermeasures for earthquake-related disasters

(1) Organizational structure

How the measures against natural disasters/ accidents are established and how disaster prevention system are constructed are explained in the Civil Defense Law no.106/1996. The measures are decided by a central disaster prevention committee (Central Committee) organized at the government level. What disaster each ministry takes charge of is decided according to the kind of disaster/ accident (refer to 7-7-2). According to this law, the Ministry of Public Works, Transports and Housing (MLPTL) takes charge of landslide disasters and highway accidents, etc. including earthquake disasters. MLPTL also takes charge of initializing the national plan for measures against earthquake disaster. Each local government (counties and municipalities) has also a special organization, which takes charge of any countermeasures proposed.

(2) Current conditions of earthquake disaster prevention

MLPTL, as an earthquake disaster prevention organization, currently implements its retrofitting project for the existing fragile buildings. MLPTL forecasts that similar damage to the 1977 earthquake disaster would occur in case of a future great earthquake. To promote retrofitting of the existing buildings, Government Ordinance no.20/1994 was enforced in 1994 (refer to 2-4). However, if the current situation is examined, although the legal system to promote retrofitting has been prepared, the retrofit-work is not progressing extensively. There are only 4 buildings being worked on by contractors at present (refer to 2-4), although 26 of 548 buildings, which may collapse in the event of another great earthquake, are planned to be retrofitted by contractors in 2002. The main reason for the lack of progress is that the cost of retrofitting is not easily secured due to budget shortage. Another main reason is that the Government does not have an cost and time effective method for retrofit-work, which would enable faster work at a lower cost.

MLPTL also implements measures for preventing building collapse by enforcing seismic standards. The importance of these measures is explained in the Action Plan (refer to 2-3). Since seismic standards were firstly issued based on the lesson of the great earthquakes of 1940, they have subsequently been revised based on the records of the 1977, 86, and 90 earthquakes. The present seismic standard is called "Code for Earthquake Resistant Design of Residential Buildings, Agrozootechnical and Industrial Structures (P100-92)", which was revised based on the 1986 and 1990 earthquake records[1]. However, this seismic standard still needs to be improved,

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[1] This corresponds to notification of minister, and structural engineers must design buildings according to this code. There are other concerned codes: Code for RC Frame Structure (NP007-1997), Code for Masonry Structures (P2-1985), and Code for RC Shear-Walls

as the quality and quantity of earthquake records for studying seismic standards are not sufficient (refer to 3-2). Also data and knowledge about the effect of local ground condition to input earthquake- ground- motion for buildings are limited.

2-3. Host country strategies: Action Plan of the Governance Program (2001-2004)

In the Governance Program issued in February, 2001 (References 8), the following issues were addressed: i)relaunching economic growth; ii)fighting poverty and unemployment; iii)restructuring of central and local government; iv)diminishing bureaucracy, fighting corruption and criminality; and v)furthering and accelerating the process of integration in the European Union and NATO. These were seen as the key issues to ensure the country's development and to stabilize political, economic, and social conditions. In this Action Plan, there are "activity fields" and "activity items" for realizing and explaining the key issues. The "activity fields" are categorized into business environment, agriculture, forestry development, territory planning, transport, infrastructure, tourism, environment, etc. "Activity items" explain what to do in the "activity fields".

With regard to "activity fields" and "activity items" relating to this Project, and in the issue of "i) relaunching economic growth", the following activity fields and activity items are explained.

(1) Activity field: territory planning (Excerpt: main activity items are shown.)
(1)-1. To develop and harmonize the legislative and technical framework with regard to international regulations (i. juridical regulations facilitating intervention and insurance against seismic risk; ii. technical regulations concerning post-earthquake intervention; iii. technical regulations concerning seismic design) and to reduce seismic risk,
(1)-2. To check the enforcement of Governance Ordinance no.19/1994 regarding the funds for construction of the houses in 2001-2004,
(1)-3. To distribute budget allowances for house construction by-enforcing Law no.114/1996,
(1)-4. To support the activity of ANL (National Housing Agency)(in the construction of 28,000 apartments for general citizens and 38,000 apartments for younger couples),
(1)-5. To take legislative and administrative measures in order to urgently complete unfinished buildings during the term of 2001- 2004,
(1)-6. To cooperate with other ministries and thus construct kindergartens, schools, libraries, hospitals, etc.
(1)-7. To construct 400 sport halls for education at all levels, in towns and villages, at a rate of 100 per year during the term of 2001-2004
(1)-8. To take legislative and administrative measures in order to urgently complete unfinished buildings including temporary buildings for the owners, buildings of whom are retrofitted,
(2) Environment (one item)
(2)-1. To retrofit buildings according to the seismic code in force.

2-4. Prior and ongoing project/ assistance

2-4-1. Prior projects

The seismic standard has been in a process of revision since 1940, although there still exist some technical problems in the standard (refer to 3-2). On the other hand, as has already been mentioned, building retrofitting is not progressing extensively. In 1994, the central and local governments created a legal system for promoting building retrofit. This new initiative allowed important public buildings such as schools, hospitals, courts, police stations, and museums, etc., to be retrofitted by the state budget. However, the residential buildings of private owners have largely not been retrofitted extensively.

Structures (P85-1996). The structural engineers must obey these codes, too.

With regard to the present conditions of retrofit works of residential buildings, only limited structural elements such as columns and walls damaged by earthquake have been repaired, and the work has not been done properly due to inappropriate engineering method. This is one of the reasons why the government initialized the legal framework of 1994 and promoted the appropriate retrofitting of fragile buildings, especially ones of an individual or residential nature. The government intends to retrofit existing fragile buildings urgently to mitigate the risk of future building collapse.

2-4-2. Ongoing projects

(1) Building retrofit project by MLPTL

The government enforced the Government Ordinance no.20/1994 in 1994 as described before. It has been subsequently promoting the retrofit of buildings that may collapse. This was the first legal framework for promoting retrofit.

MLPTL, according to this ordinance, gave notice to all counties (and Bucharest Municipality)[2] to examine the seismic risk factor of all the buildings from their age and condition of their structures, and to classify them into risk degrees (I-IV). 3,400 buildings (2,453 in Bucharest) were duly examined in this way, 2,605 of which were technically inspected by authorized experts. As a result, 548 buildings (341 in Bucharest) were recognized as Class I buildings (the most fragile buildings that may collapse). Furthermore, 200 of the Class I buildings, which were built before 1940 and have five or more floors, were recognized as the most fragile buildings of all. The following table shows the number of the most fragile buildings categorized by city. It can be seen that 200 buildings were recognized in 12 cities (see Table 1);115 buildings were recognized in Bucharest (refer to 7-7-3). This number accounts for half of all the recognized buildings.

Table 3. Number of the Most Fragile Buildings (categorized by city)

City (Population)	Bacau (201.3)	Barlad (78.3)	Braila (232.4)	Brasov (312.5)	Bucharest (2,080,6)	Buzau (114.6)	Campina (40)	Iasi (347.6)	Roman (81.7)	Suceava (118.1)	Targu-Mures (164.1)	Vaslui (78.7)
Number of the most fragile buildings	6	6	4	8	**115**	1	2	49	1	1	1	6

(source: interview survey at MLPTL)

(i) Institutional framework of retrofit work (support system for the owners of the most fragile buildings)

Romanian Government presents a support system for the owners of the above-mentioned fragile buildings (115 of which are in Bucharest). The support system is prepared based on a government notice (*Official Gazette of rdinance No20/1994: Part I, no.150, and 15/04/1998*). According to this notice, if owners belong to the public sector or use their buildings for company management, the owners are not supported. If, however, the owners are individual, they can receive some or all the support comprising of payment of the retrofit cost (cost for risk check by authorized engineers, drawing for retrofit, and retrofit-work by contractors) (see below: contents of the support are explained categorized by the owner).

Retrofit-work by contractors needs approval from all the owners before it can go ahead. The Technical Specialty Commission of MLPTL judges whether the cost of the retrofit work is supported by the public budget. If it is considered necessary, temporary buffer apartments are allocated for the owners while their buildings are being retrofitted.

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[2] Administrative body, which corresponds to prefecture level. They are sometimes officially called "county" or "district" in English. There are 41 Counties (as of July, 2001). Bucharest Municipality is a special municipality, administrative level of which corresponds to a County.

(a) If the owner belongs to the public sector (central or local government),
The owner (central government (ministries) or local government) needs to pay all the retrofit costs (cost for risk evaluated by authorized engineers, drawing for retrofit, and retrofit-work by contractors).

(b) If the owner belongs to the private sector and use a building for company management,
The owner needs to pay all the retrofit costs (cost for risk evaluated by authorized engineers, drawing for retrofit, and retrofit-work by contractors).

(c) If the owner is an individual; the owner's building is NOT categorized in Class I,
The cost for risk evaluation by authorized engineers is covered by MLPTL, in other words, the cost is derived from the public budget. However, the owner needs to pay for the costs of drawing for retrofit and retrofit-work by contractors.

(d) If the owner is an individual; the owner's building is recognized as a Class I building, which has five or more floors, and the annual income of the owner is below mean level,
All of the retrofit cost (cost for risk evaluation by authorized engineers, drawing for retrofit, and retrofit-work by contractors) is covered by MLPTL. In other words, the owner can receive full support.

(e) Categorized as above and if the individual owner's annual income is above the mean level
The owner needs to pay for the costs of drawing for retrofit and retrofit-work by contractors, but the owner can pay the costs by 25-year interest free loan, . If the owner's building is used for both public and/ or private sector purposes, the special support is applied only to the individual owner.

The retrofit project by MLPTL is implemented by following procedures, the main 3 stages of which are i)risk evaluation by authorized engineers, ii)drawing for retrofit-work, and iii)retrofit-work by contractors.

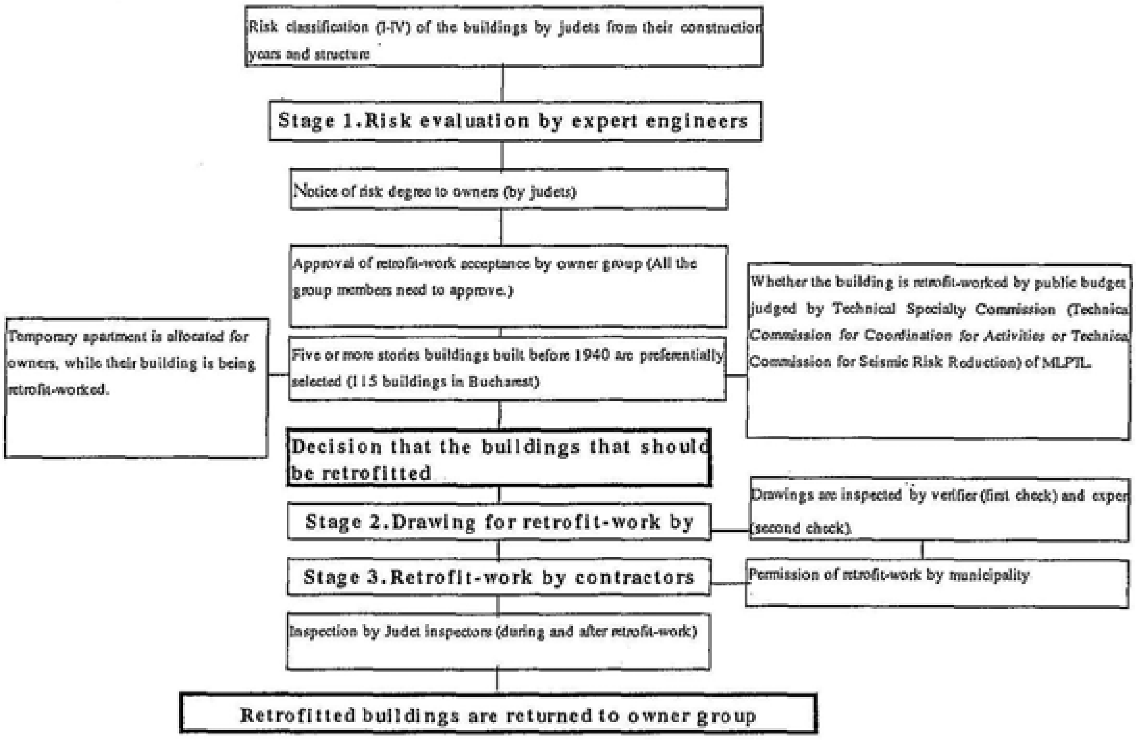

Figure 2. Procedures of Retrofit-work based on Government Ordinance (No.20/1994)

"Verifiers" and "Experts" are involved in the retrofit project in the stage 1 and 2. 'Verifier' is the title for the engineer who has had at least 8 years work experience and has passed an examination by MLPTL. Verifiers are categorized by their engineering fields including building structure, and mechanical equipment (for fire prevention and water supply/ sewage), etc. 'Expert' needs at least 15 years work experience (or 10 years experience if an engineer has a special work experience). In a similar way to the verifier, this title is given to the engineer who has passed an examination by MLPTL. The possible engineering fields of experts are also categorized in the above-mentioned fields. The number of registered verifiers and experts (structural field, August 2001) are shown in the following table.

'Inspector' is an officer of a local authority and an engineer, and takes charge of inspection of retrofit-work by contractors. The title of Inspector's qualification does not require any examinations to be passed.

Table 4. Number of Verifiers and Experts (Structural Field) (August, 2001)

	Bucharest	Romania
Verifier	418	790
Expert	219	424
Total	637	1,214

(Source: Interview survey at UTCB)

(ii) The Present conditions of building retrofit

If the above-mentioned 3 stages: i) risk evaluation by the authorized engineers; ii) preparation of drawing for retrofit-work; iii) retrofit-work by contractors, are looked at, there have been 2,605 buildings risk-checked (stage i), and drawings for retrofit-work have been prepared for 26 buildings (8 in Bucharest) (stage ii). In respect to stage iii, there are 4 buildings that are currently being retrofit-worked, and another 5 buildings are under bidding process for retrofitting works.

In respect to the budget allocations to retrofit projects by MLPTL, the total amount in 2001 was 55 billion lei: 4.3 billion lei of which was allocated for risk evaluation for other buildings; 6.2 billion lei was allocated for drawing for risk-checked buildings; 44.5 billion lei[3] was allocated for retrofit-work by contractors. There is a plan to allocate a budget of 55 billion lei for promoting retrofit in every subsequent year. Although the budget may have to be reduced due to economic conditions, at the time of writing there is a policy to have the above 115 buildings in Bucharest retrofitted during the expected Project term (5 years). In line with this policy, the following is anticipated to take place.

Table 5. Retrofit - Work Plan for 115 buildings in Bucharest (see ii and iii)

	~2001	Project Term					total
		2002	2003	2004	2005	2006	
□ .Risk evaluation by authorized engineers (total buildings in Romania)	2,605	15	15	15	15	15	2,680
□ .Preparation of drawings for retrofit work) (115 buildings in Bucharest)	6	4	20	20	30	35	115
□ .Retrofit-work by contractors (115buildings)		10	20	20	30	35	115

(Notice: Numbers in (i) show the buildings in Romania)

(2) Retrofit project for school buildings by Ministry of Education and Research: MER

MER, according to the Government Ordinance No.20/ 1994, implements retrofit projects for school buildings in cooperation with MLPTL. The risk degree of school buildings is judged from the viewpoint of the following; regional risk (If the MSK scale is 7 or more), population density, building age, risk degree of building and historical importance. The engineer who belongs to each county and liaises with MER's activities takes charge of the risk-degree categorization. Results of the categorization by the engineer are reported to the person in charge of MLPTL 's activities in the county.

At present, there are 1,800 school buildings that are considered to be in urgent need of being retrofitted. 500 of these are ones that should be preferentially retrofitted. Among the 500, there are 397 schools (4,786 classrooms) (13 schools in Bucharest) which need risk-evaluation; 71 schools (1,606 classrooms) (7 schools in Bucharest) which need preparation of drawing for retrofit-work; 32 schools (1,102 classrooms) (2 schools in Bucharest) which now need retrofit-working by contractors. The total cost for the MER's retrofit project is estimated to be 3,827 billion lei (148 million US dollars).

With regard to the retrofit plan for university buildings, there are 152 buildings, housing 131,000 students, which are scheduled to be retrofitted. Of these64 (29 in Bucharest) of the 152 buildings need risk-evaluation; 47 buildings (14 in Bucharest) need preparation of drawing for retrofit-work, and41 buildings (13 in Bucharest) need retrofit-work by contractors. The total cost for the retrofit plan for the university buildings is estimated to be 4,459 billion lei (173 million US dollars).

In 2001, MER's budget for its retrofit project was79.6 billion lei. MER also hopes to receive financing from the European International Bank to aid its retrofit-work. In particular the budget for retrofit-work by contractors (stage

[3] In 2001 there were 17 buildings that should be retrofit-worked by contractors, but the retrofit-works were not put into practice because the owner groups in the buildings had not agreed on the retrofit-work. However, it is expected that the groups accept the retrofit-works in 2002.

3) is expected to be procured from other supporting organizations. Therefore, the target year for completion of the retrofit project is not clearly defined.

Table 6. Number of School Buildings in need of being retrofitted (Number of Universities is not included. See Table 5)

	Stage 1(Risk check by authorized engineers)	Stage 2(Preparation of drawing for retrofit-work)	Stage 3 (Retrofit-work by contractors)	
	Number of school buildings	Number of school buildings	Number of school buildings	Total
Romania	397	71	32	500
Bucharest	13	7	2	22

(References 10)

Table 7. Number of University Buildings in need of being retrofitted

	Stage 1(Risk check by authorized engineers)	Stage 2(Preparation of drawing for retrofit-work)	Stage 3 (Retrofit work-by contractors)	
	Number of school buildings	Number of school buildings	Number of school buildings	Total
Romania	64	47	41	152
Bucharest	29	14	13	56

(References 10)

(3) Retrofit project for hospital buildings by Ministry of Health and Family: MHF

MHF is implementing its retrofit project for hospital buildings in cooperation with MLPTL as well as MER is. The risk degree is judged from the viewpoints of regional risk (If the MSK scale is 7 or more), the type of hospital (regional or emergency), and the number of beds. The engineer who belongs to each county and relates to MHF's activities takes charge of risk categorization. The results of categorization by the engineer are reported to the person in charge of MLPTL 's activities in the county.

At present there are 276 pavilions (buildings) (in 103 hospitals) in need of being retrofitted. 172 pavilions (16,731 beds) (in 36 hospitals) of all the 276 pavilions need risk-evaluation by authorized engineers; 64 pavilions (in 29 hospitals) need preparation of drawing for retrofit-work; 40 pavilions (in 38 hospitals) need retrofitting by contractors. In Bucharest alone, 16 pavilions (4,090 beds) need retrofit-work. The total cost for this MHF's project is estimated to be 4,092 billion lei (158 million US dollars). In 2001, MHF's budget for the retrofit project was 137.9 billion lei. In addition MHF again plans to receive financing from the European International Bank to procure the fund for 50 percent of the estimated cost for retrofit (79 million US dollars). As well as the case of MER, some of the budget (especially, the budget for retrofit-work by contractors (stage 3)) is expected to be procured by other supporting organizations. Again the target year of completion of the retrofit project is not clearly defined.

Table 8. Number of Hospital Buildings in need of retrofitting

	Stage 1(Risk check by authorized engineers)	Stage 2(Preparation of drawing for retrofit work)	Stage 3 (Retrofit-work by contractors)	
	Number of school buildings	Number of school buildings	Number of school buildings	Total
Romania	172	64	40	276
Bucharest	13	18	16	47

(References 11)

(4) Present conditions of other ministries' retrofit projects

The ministries of Justice, Interior, Culture, Tourism, Sports, Environment, and Water Supply all implement retrofit of their own buildings (in particular highly important public buildings such as courts, police stations, museums, hotels and stadiums[4]), although the number of buildings is small compared with the number of MER's and MHF's projects.

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[4] The important buildings are defined in "Code for Earthquake Resistant Design of Residential Buildings, Agrozootechnical and Industrial Structures (P100-92)"(refer to 2-2-3(2)). Concerning technical assessment on seismic check of these buildings and approval of drawings for

2-4-3. Related projects financed by other foreign development agencies

Romania began to exchange information in the field of earthquake engineering/ seismology with other countries in 1989. At present, the projects which are financed by other foreign development agencies are classified into the fields of i) earthquake prediction, and ii) damage analysis of urban areas (see following descriptions: the project name is noted). Romania has contacted the World Bank (WB), France and Germany, etc. and has requested technical assistance. At present Romania is requesting help not only from Japan in the field of development of retrofit-techniques and seismic codes, but also from the WB in the field of establishment of organization structures for reducing damage from natural disaster including earthquake.

At present, any supporting organizations are not yet related to building retrofit that the Romanian government puts emphasis on.

(1) Safety of Building in Romania to Earthquakes (Grant No.16/198 of the Ministry of Education of Romania)(1999-2001)(Supported by World Bank)

The main aim of this project is to foster younger researchers who belong to universities/ institutions in Romania. This was supported jointly by the Ministry of Education and Research (MER) and the World Bank. There were research themes prepared for by the participating universities. The researchers of Technical University of Civil Engineering, Bucharest (UTCB) took charge of the risk analysis of the Banat Earthquake which occurred in 1990-91(of which there is a strong possibility of reoccurrence) as well as the risk analysis of the buildings in Bucharest, which were weakened by the 1977 Vrancea Earthquake. The Politechnica University in Timisoara coordinated the research papers, which were prepared by each participating university. The components of the package, which UTCB received, consist of some equipment (one computer, one printer, and software (MatLab, Stratgraphics)) as well as an allowance for the attendance of an international conference in the United States.

(2) Seismic Microzonation of the City of Bucharest-Romania(1997-2000)

(Supported by Association Francaise du Genie Parasismique:AFPS)

AFEP completed technical assistance in the preparation of a seismic microzonation map. This is classified as part of the project, which France offers to francophone countries all over the world. Through this project, the seismic microzonation map, which shows earthquake information in Bucharest, was created and the regional risk in Bucharest was analyzed to some degree. However, it has not functioned as the medium for judging building standards (design code), since observed data from the 1986 and 1990 earthquakes were quite limited.

(3) Strong Earthquakes: A Challenge for Geosciences and Civil Engineering (German Foundation Grant SFB461 at Univ. of Karsruhe)(1995-2001)

This is a joint research project by research organizations in Romania and the Karlsruhe University in Germany. The purpose of the research is to elucidate the epicenter of the Vrancea earthquake. The Karlsruhe University equipped 36 digital seismographs (K2 Kinemetrics) in the territory of Romania as part of the project.. However Germany, not Romania, owns the seismographs, although most of them are operated by INFP (National Institute for Earth Physics) in Romania..

The purpose of this project is to examine geophysical characteristics (related to earthquake research/observation, earth's crust structure and dynamic characteristics, etc.). If the German Government officially agrees, it will be possible to obtain and utilize the data through INFP.

(4) Other activities in the international projects (RADIUS Project and RISK-UE)

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retrofit work, MLPTL's examination is needed.

Some researchers have actively exchanged information with other researchers in foreign countries through international projects in order to improve knowledge and skills..

i) United Nations RADIUS Project (Risk Assessment tools for Diagnosis of Urban areas against Seismic disasters) & United Nations Project Understanding Urban Seismic Risk around the World (1997-99)

The Secretariat of "The International Decade for Natural Disaster Reduction" of the United Nations implemented this project for promoting earthquake-disaster prevention. This initiative was implementedall over the world, especially inurban areas of developing countries. 9 large cities: Addis Ababa(Ethiopia), Antofagasta(Chile), Bandung(Indonesia), Guayaquil(Equador), Izmir(Turkey), Skopje(Macedonia), Tashkent(Uzbekistan), Tijuana(Mexico), and Zigong(China) were selected as cities forcase study, seismic damage scenarios for the cities were then studied with technical assistance of research organizations in Japan, America and France. Disaster prevention plans were also suggested.

More than 70 cities participated in this project including Bucharest in Romania. The countries that participated in the research compared the risk of earthquake occurring in their representative cities.

ii) RISK-UE: An Advanced Approach to Earthquake Risk Scenarios, with Application to Different European Towns (2001～)

This is an international project on the prediction of earthquake scenarios for major European cities. 15 organizations from 7 countries (France, Italy, Spain, Romania, Bulgaria, Greece, and Macedonia) participated in the project. Romania was represented by both UTCB and MLPTL

3. Problems to be addressed and the current situation

3-1. Problems concerning buildings retrofit

From the technical point of view, there are a variety of retrofit methods corresponding to the structural type of the building as well as the performance of the structure. Therefore, the present technique for building retrofit should not be regarded as an ideal one. In particular, in the case of retrofit methods for buildings in Romania[5] that have a large disparity between the target seismic performance and the existing seismic performance for retrofit, there are a number of problems that have to be considered. This is because the effectiveness of existing retrofit methods (improvement of performance) has not been perfected. In Japan, rebuilding is generally practiced when the seismic performance is far poorer than desired. Retrofitting is opted under the condition present seismic performance is comparatively sufficient and could be improved some 10 % to the target value. On the other hand, in Romania it is not easy to practice rebuilding because there is a need to preserve the existing landscape and appearance of the building. Therefore, it is necessary to introduce a retrofit-method to raise seismic performance to twice or three times as much as the existing value.

Under such conditions, a new retrofit project was implemented by MLPTL. However, the retrofit-method introduced in the project was traditional one generally used in Japan for the case that the degree of improvement level for retrofit is relatively small. If one of the retrofitting methods is looked at, it is assumed that retrofit is practiced by increasing the volume of columns with reinforced concrete. The volume is sometimes increased up to twice as large as the existing column's volume (this method is inefficient in cost and time but is practiced in almost all cases in Romania).

The cost of retrofit by using this method could be high and this should not be considered wholly effective. If it is assumed that the 115 most fragile buildings in Bucharest have to be retrofitted in the short term, there needs to be

[5]There exist a lot of old buildings that should be retrofitted in Romania. Non-engineered structural building is included, and its seismic performance is not appropriately evaluated.

lower seismic standard in order to reduce the cost of retrofit.

Therefore, it is essential to assess the seismic performance of the building at the point of its construction. This survey needs to be practiced by collecting/ surveying design documents and analyzing the main seismic elements. It also needs the collection of technical information on how seismic performance is improved by following existing strengthening methods: i.e. the use of reinforced concrete; carbon fiber and other technical methods. It is then necessary to suggest the appropriate, feasible and effective methods for retrofit, corresponding to the type of building. This will incorporate the development of an appropriate retrofit method, and an evaluation of the buildings subsequent performance.

Of course, as the first stage of MLPTL's retrofit project, it is necessary to implement the MLPTL's project before new retrofit methods are developed in the Project. Therefore technical support should be provided concurrently with MLPTL's project. If the above-mentioned optimized retrofit method/ performance evaluation is not developed/ practiced then the present MLPTL's retrofit project would end up in ad-hoc remedy.

3-2. Problems concerning seismic regulations/codes for building

(1)Lack of data accumulation of earthquake record

In Romania seismic regulations were introduced after the 1940 earthquake of magnitude Mw7.7, in which 267 people were killed. At the time of the 1977 earthquake of magnitude Mw7.5, in which1,570 people or more were killed. Seismic regulations were revised based on this earthquake record, and in 1986 (Mw7.2) and 1990 (Mw6.9), the regulation were revised again by raising degree of seismic level and introducing soil clarification.

Generally, input design earthquake-ground-motion is defined by epicenter characteristics, transmission characteristics, ground conditions, and characteristics of earthquake-ground-motion in relation to buildings. Under the present seismic regulations of Romania, (horizontal) seismic force which affects buildings horizontally is calculated corresponding to the importance of the building, the regional seismic coefficient, ground conditions, dynamic amplification coefficient etc. Although the calculation method is well considered, there are some problems concerning its level and content.

For example, if the base shear coefficient (horizontal seismic force transmitted to building) is considered, the coefficient has been revised from 0.05 to 0.10, which is only one-third of the seismic standard used in Japan. Because the number of earthquake-motion-records was so small in Romania, there is a doubt whether or not the buildings designed by the revised standard are safe enough and characteristics of earthquake-motion were adequately evaluated.

Moreover, although "dynamic amplification coefficient corresponding to ground conditions" is introduced in the present seismic regulations, there are only three values defined in the whole country. For instance, in the southern region of the country including Bucharest, the same coefficient value is introduced. Furthermore there is no enough earthquake damage information (regarding how the damage is distributed) based on ground conditions. It can again be seen that the lack of earthquake record accumulation has caused some problems.

If the data of the record of the 1977 earthquake is looked at, there is only one earthquake- motion- record, which was obtained in INCERC, Bucharest. Most earthquake-motion-records are still observed by using analog seismographs equipped on the free field; apparently they are insufficient in both quality and quantity compared to the ones used in Japan. In particular the practical records on how a building is affected by earthquake-motion are not sufficiently accumulated. In other words, the affect by transmission of earthquake-motion, the characteristics of earthquake-motion in the surface layers of various ground conditions, the response characteristics of buildings, as well as other factors are not well evaluated. Also, the effect of earthquake-motion on buildings may not be well considered.