GOVERNMENTAL ROLE IN MITIGATING THE IMPACT OF EARTHQUAKES IN YUGOSLAVIA

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Introduction

While natural phenonena cannot be avoided, at least at the present state of our knowledge and ability, nevertheless, the impact of a natural phenomenon on human lives and property can be mitigated.

Recent earthquake disasters in Montenegro, Al-Asnam, South Italy and Greece have proved once again that the main problems of earthquake protection are the disaster prevention measures to be taken by governments in order to avoid the loss of lives and the destruction of property, as much as possible. The analyses of the impacts of all these disastrous earthquakes have shown that the scope of the disaster could be substantially mitigated if appropriate governmental predisaster measures were adopted and realized before the earthquakes.

At present a great deal of theoretical and experimental research in the field of earthquake engineering has been carried out or is still in progress in many parts of the world. In the last decade tens of thousands of reports have been presented at various international conferences all over the world. Nevertheless, every new earthquake proves that the protection of human lives and property has not been essentially increased during recent years.

This is due mainly to the fact that most of the governments of the countries with earthquake prone areas, where earthquakes occur sporadically, are not sufficiently aware of the social and economic impact of disastrous earthquakes. As a consequence these governments have not prepared measures to mitigate the impact of strong earthquakes nor have they been able to organize and carry out emergency measures immediately after the earthquake disaster. Usually the first strong disastrous earthquake triggers governmental activity of this sort. Sometimes little by little this activity diminishes when no new strong earthquake occurs for a long period.

Disaster Prevention Measures

In Yugoslavia the first earthquake protection measures were instituted in Slovenia after the strong earthquake of 1895 in Ljubljana--intensity about VIII degrees MCS scale. There were no reinforced concrete structures at that time, but the design and technology of brick structures after the earthquake were improved. Since no earthquake resistance

analyses of structures were available then, increasing the seismic resistance of brick structures was accomplished by means of increasing the thickness of bearing walls, which were thickest in the first story and diminishing in the upper stories. In this way the center of gravity was lower and the bearing section was the strongest at the base, where the highest stresses from earthquake loading occurs.

After the earthquake in 1895 a seismological station in Ljubljana was established, one of the first in Europe, equipped with up-to-date instruments.

In the first part of this century between the two World Wars requirements for very low horizontal loads for seismic analysis were adopted in standards of building loading, namely uniform horizontal load of only 2% of the weight of the structure. This requirement was kept also after World War II. However, a number of small earthquakes felt in Slovenia at this time as well as the development of earthquake engineering in the world, stimulated the Slovenian ministry for industry and building to create a special governmental commission to prepare updated regulations for earthquake resistant design. These new regulations were adopted by the government of Slovenia in 1962.

After the disastrous earthquake of Skopje in 1963, these regulations with minor additions were adopted in 1964 for the whole territory of Yugoslavia. The philosophy of the regulations is as follows: since the complete protection against any damage of all kinds of buildings for the strongest possible earthquake is economically not feasible, the earthquake resistant regulations should provide security for human lives in the case of a major earthquake in a region, however, permitting some amount of structural damage.

This means that buildings in any case should not collapse nor suffer such damage as to endanger human lives. The bearing structure should resist the strongest earthquake without heavy damage. These regulations also introduce a sophisticated approach to structural design by the use of the dynamic response analysis. The influence of local geological conditions is also taken into account.

Thus the regulations insured the proper design of buildings to be built in earthquake prone areas. However, design alone cannot ensure earthquake protection. Construction on the site according to the adopted design must be assured through strict supervision of the quality of materials and technology of construction.

This problem is not completely resolved satisfactorily in our legislation as yet, but we are on the way to finding the right solutions for it. We have at present no governmental regulations about town planning in earthquake regions, but professional organizations have made a number of recommendations.

All of these regulations govern the construction of buildings to be built in the future. However, most of the buildings in Yugoslavia were constructed before the adoption of modern earthquake resistant regulations. The problem of how to provide earthquake protection for all these older buildings is a very complicated one from the juridical, economic and technical points of view.

The easiest problem is the technical one. We have developed in Yugoslavia efficient methods for reinforcing and strengthening existing buildings in order to ensure their earthquake resistance. More complicated is the problem of finding the necessary financial means for executing reinforcement, but the juridical problem is probably even more difficult. How can one justify compelling an owner to spend money for the reinforcement of his own house.

The parliament of Slovenia adopted in 1978 a law which is called: the law on the seismological service. This law not only defines the duties of the Seismological Institute of Slovenia, which is created by this law, but also institutes measures to ensure the protection of some existing buildings, built before the adoption of the seismic resistant regulations. Since it was not feasible to force the private owners of houses and dwellings to reinforce them, the requirements of this law are limited only to important public buildings, namely:

- buildings the collapse of which could cause further disasters such as nuclear power plants, warehouses of toxic materials, high dams;
- buildings which are important for relief after earthquakes such as hospitals, fire stations, water supply stations, communication centers, power stations;
- buildings where many people congregate, such as theaters, cinemas, schools, kindergartens;
- very high buildings and buildings with large spans;
- precious cultural monuments;
- the most important governmental buildings.

The Seismological Institute is a governmental body, which is empowered by this law to establish the procedures by which the analysis of the seismic resistance of these buildings should be carried out. If the analysis shows that the structures are not sufficiently resistant to the seismic intensity of the area, the users (owners) of these buildings must reinforce them. The modes of the reinforcement, specifically the time period for compliance, are to be determined by the building authority of the commune where these buildings are located. If the user of a building does not reinforce the structure within the specified time, this authority can forbid use of the building. This law is a lex perfecta which means also that penalties are provided for those who fail to meet its requirements.

The introduction of this law in practice is still in the very early stages, and we are aware that in the realization of its requirements many problems and difficulties will emerge. However, the law exists, and sooner or later it must be respected. The problem of the protection of rural houses and private dwelling houses is not as yet resolved by this law. Some owners reinforce their houses at their own expense, however, they are very few.

One can also consider as disaster prevention measures governmental regulations which provide funds to ensure financial means for emergency measures immediately after an earthquake and for later relief and reconstruction. Strong earthquakes cause such immense amounts of damage that stricken cities or communes cannot restore all the damage from their own resources. Therefore, in Yugoslavia there have been created at various administrative levels (commune, republic) solidarity funds which can be used in the case of severe natural disasters to provide relief and reconstruction assistance to stricken areas. These funds cannot be used for relief after every natural phenomenon which causes damage, but only for

those which are considered as disasters causing an amount of damage in a specified rate to the GNP of the stricken administrative unit. The interrepublican agreement has set as the threshold for this amount the value of 3% of the GNP of the corresponding administrative unit of the year before the disaster. This means that if the amount of damage to a commune exceeds this limit, other communes, respectively the full republic, must assist by means of these solidarity funds. The very strong earthquakes of Skopje (1963), Banja Luka (1969), and Montenegro (1979) caused damage which exceeded 3% of GNP of the republics of Macedonia, Bosnia and Hercegovina, and Montenegro. Therefore, all republics of Yugoslavia, according to the agreement, were obliged to provide financial assistance from their solidarity funds or from elsewhere to ensure the relief and reconstruction of the damaged areas.

The percent of the participation of each republic in meeting the full amount of the damage is determined by the ratio of the GNP of the republic to the national GNP of Yugoslavia. If the amount in the solidarity funds of all the republics is not sufficient to cover the full damage, a special federal law is issued which imposes a special personal tax based on a percent of wages for the entire population of Yugoslavia for several years. The solidarity funds in each commune and republic are created according to the above mentioned agreement of 1974 in such a way that every year the amount of 0.2% of GNP of the year before must be paid into the solidarity fund. This payment continues until the amount of the fund reaches the value of 2% of the GNP of the year before in the commune and republic respectively.

Post-Disaster Measures

Councils (staffs) for civil protection against natural disasters are established in all administrative units of the country (commune, republic, federation). The local council of the commune (respectively of the republic if the disaster exceeds the bounds of the commune), leads the local emergency relief of the stricken area and contacts the councils of other communes (or republics), in order to obtain necessary assistance (tents, medicine, surgeons and physicians, engineers, etc.).

One of the first important tasks of the local civil protection staff after a disastrous earthquake is to determine the serviceability of damaged buildings. During an earthquake many buildings, houses, and dwellings suffer damage to the bearing and nonbearing elements of the structure. The inhabitants usually are not able to assess the meaning and importance of various cracks of the structure. Fear caused by the earthquake and the uncertainty of the security of their houses leads the population to approach civil protection staffs requesting temporary shelter. This may complicate the actions of emergency relief staffs, which at the first moment usually do not have enough temporary shelters available.

The evaluation of the serviceability of damaged buildings after an earthquake is one of the most important tasks of the emergency staffs. This task can be accomplished only by specialized engineers familiar with the problem of the statics and dynamics of structures. Disastrous earthquakes cause such quantities of damage that the local available staff of engineers is not sufficient to fulfill this task in a short time. Therefore after major Yugoslav earthquakes (Skopje, Banja Luka, Montenegro), engineers from all Yugoslav republics were engaged to accomplish this task. The involvement of engineers recruited from other republics was on a free basis.

For engineers from enterprises and companies, the loss of income was restored from the solidarity funds.

The main task of the first staff of engineers is to determine the serviceability of buildings. Therefore, all buildings in the stricken area are marked with one of the following colors:

- green for serviceable buildings;
- yellow for buildings which must be repaired before using; and
- red for heavily damaged buildings beyond repair.

This classification by means of three colors was used in the earthquakes of Skopje (1963), Banja Luka (1969), Slovenia (Friuli 1976), and Montenegro (1979). In the case of Montenegro subdivisions of each color (one, two, or three lines) were used to show the degree of damage, primarily for later evaluation of the cost of repair or rebuilding.

The evaluation of damage from the point of view of serviceability is a very responsible and complicated task, since it is impossible to predict if new strong shocks can occur in the near future. Frequently within one to five months after the first strong shock a second shock, usually slightly weaker than the first one, can occur. This can be even more dangerous for buildings than the first one, since the bearing capacity of the structure was already weakened by the first shock. Therefore, the decision about the serviceability of buildings must be taken with a great deal of caution, having in mind the possibility of the occurrence of aftershocks. The second task of engineers and technicians is to evaluate the amount of damage in order to determine the financial resources required for the repair and reconstruction of buildings.

The evaluation of damage must be carried out uniformly since in the case of a disastrous earthquake all republics participate in collecting the financial resources for reconstruction. In order to avoid disagreement between recipients and donors of assistance, a federal unified methodology for evaluation of damage after natural disasters was adopted in 1979. This methodology defines how to evaluate the damage to buildings and civil engineering structures, the damage to equipment, the loss of income due to shutdown in the industry, the cost of the emergency relief, etc. The problem of reconstruction of damaged buildings has to consider the previous level of resistance of the damaged building before the earthquake as well as the requirements for resistance according to the seismological map of the region. The resistance of old buildings usually was not sufficient for the seismic intensities, which have been defined in recent times on the basis of the new seismological maps. Problems arise in reconstruction as to whether the building should be restored to its status prior to the earthquake or should be reconstructed to ensure higher resistance, corresponding to the seismological maps of the country where the strongest intensity of the earthquakes to be expected in the region are indicated.

The solution of this problem in Yugoslavia was the following: the reconstruction of public buildings should be carried out in such a way that the resistance of the reconstructed structure should correspond to the requirements of seismic resistance according to the seismological map. For private houses it is up to the owner to decide how to use the loans which are granted under favorable conditions for the reconstruction of his house. From the technical point of view various methods for reinforcement and strengthening of brick and stone buildings are developed. The program for the reconstruction of the area stricken by the earthquake is to be developed

by the commune or republic respectively and should be approved by the council for civil protection and other authorities in the republic or federation respectively.

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