3 Earthquake Damage Data Collection

3.1 Information required and Procedure for Data Collection

Earthquake damage data collection based on the uniform methodology should be organized with the procedure and organizational modes suitable for rapid data collection, day to day reporting of the inspection teams and cumulative presentation of the data to damage inspection headquarters of the sectors, communes and the entire earthquake affected region, which in the case of large-scale earthquakes could be spread over more than one commune or even district. The inspection headquarters at communal and/or regional level should be able to report on day-to-day basis to the responsible government authorities and prepare the final report using the inspection teams reports. To achieve the above-mentioned needs it will be of basic importance to establish, in advance, a sufficient number of well-trained inspection teams in each commune in the seismically active regions of the country as well as in the big towns and cities. During the training process, organizational preparatory measures should be undertaken in each commune and prepared in the form of Earthquake Damage Inspection Plan which should consist of the following pre-required data:

- Topographic maps of scale 1:10,000 or 1:5,000 for the commune with detailed presentation of each individual sector to be inspected and their code number pre-defined. (One sector should cover not more than 1,000 buildings of average height in the region considering that 3-4 inspection teams will perform damage and usability classification within one month).
- Topographic maps of scale 1:1,000 for each sector with the names of the streets, numbers of buildings and the code number assigned to each building. The code numbers of the buildings are different from the regular numbers. They should also be permanently and clearly marked on the buildings.
- Detailed analysis, plan of organization and number of the inspection teams defined and coordinated by headquarters of the sectors and the commune. Each inspection team should be identified by the names of the local specialist and the number of the additionally required inspection teams.
- Earthquake Damage Inspection Forms in three copies for each building with completed identification and structural parameters (1 through 9 and 10 through 17 of the Inspection Form). These data should be collected during the training process.
- Forms for cumulative and final presentation of the inspection results of earthquake damage and usability classification in three basic categories (green, yellow and red) by number and gross area of classified buildings.

All the above-mentioned maps and forms should be prepared for each inspection team and headquarter in separate files in a format suitable for easy handling under specific field conditions after damaging earthquakes. They should be kept at civil defence headquarters or other organizations responsible for performance of the training programme and actual damage and usability classification. These in-advance preparations are very essential for training and rapid performance of damage classification in order to assure implementation of the uniform methodology. When this is not done in advance, it should be planned to have at least one-week training courses and trial classification of the inspection teams with significant number of instructors and supervisors. The most difficult part will be the preparation of maps and forms as well as organization of the mobilization of the inspection teams under extremely difficult post-earthquake conditions.

The procedure of data collection depends very much on the level of preparations and training performed before the damaging earthquake occurrence.

If these preparations are performed in accordance with the recommendations mentioned above, the following steps of the procedure of data collection should be performed after the actual damaging earthquake:

- Mobilization of the staff of the inspection teams and headquarters;
- Distribution of in-advance prepared files for earthquake damage inspection to each headquarter and inspection team.
- Completion of Damage Inspection Forms building-by-building parallel in each sector and posting of the buildings with the colour corresponding to damage and usability classification.
- Preparation of cumulative daily and weekly reports as well as final reports of each inspection team and headquarter of the sectors and the communes.
- Submission of the cumulative reports to the commune, district and country responsible authorities for earthquake damage and usability classification.
- Archiving of one copy of the complete set of performed damage and usability classification within civil defence headquarters of the commune and submission of other two copies to the regional and country headquarters responsible for further actions for evaluation of economic losses and reduction of earthquake consequences.

3.2 Organization of Data Collection

Basic organization for data collection of earthquake damage and usability classification should be made within the Earthquake Damage Inspection Plan for the commune, where all details on number of required inspection teams and headquarters by sectors and the entire commune should be specified assuming that the entire process of data collection should be performed within one to two months after damaging earthquake occurrence. Here for the needs of basic planning organization of the inspection teams, section and commune headquarters will be considered together with the required equipment and major topics of the training course.

- **ORGANIZATION AND DUTIES OF THE MEMBERS OF INSPECTION TEAM:** Each earthquake damage inspection team should be composed minimum of three members: structural engineer, head of the team; civil engineer or architect and technician-driver.

  The duties of the head of the inspection team are to inspect the building together with the other members, to instruct completion of the Inspection Form, prepare daily, weekly and final report with cumulative presentation of inspected buildings and submit them tot he sectional headquarters and to make final decision on posting and reinspection of the building. He is responsible for performance and safety of the inspection team. The second member (civil engineer or architect) completes the Inspection Form and assists the head of the team in damage evaluation and preparation of the reports, together with the technician takes basic measures of the building outside of the building and takes photographs. The third member (technician) is responsible for collection of information about the building, drawing sketches, taking measures and posting of the building with corresponding colour. He is also driver of the team.

The **equipment** and supplies of the inspection team should be composed minimum of the following: complete inspection team file with maps and inspection forms, hard hat for each member, camera with black-and white films, flash-light, notebook, hammer, measuring band, meter, red, yellow and green colours and colour brushes.

- **TRAINING OF INSPECTION TEAMS:** The training of the inspection teams should be performed on the following aspects: mobilization procedure, team organization, use of inspection forms and reporting procedure, on-site determination of structural systems for building without benefit of plans, assessment of quality of the materials, evaluation of structural and nonstructural damage, hazard identification of nonstructural element and adjacent buildings with regard to usability and safety of occupancy and temporary bracing methods.

- **DUTIES OF SECTIONAL AND COMMUNE HEADQUARTERS:** Sectional and commune headquarters should be directly associated with civil defence headquarters strengthened by 2-3 structural engineers and several technicians. The commune headquarters should perform the following functions: preparation of the Earthquake Damage Inspection Plan of the commune, organization and performance of the training programme and in-advance required data, mobilization of the inspection teams and office force, establish communication with the regional and sectional headquarters, retrieve equipment and supplies from storage and issue to inspection teams, arrange transportation, food and housing of personnel, organize and supervise the work of the inspection teams and sectional headquarters, request protection of streets, removal of local hazard and urgent demolition, respond to citizens' requests for inspection, organize the work of the reinspection and specialist teams, prepare reports for the agencies and news-broadcasting media, conduct inspection teams through the damaged areas, archive final reports and all data on earthquake damage inspection.

  The sectional headquarters should perform the following functions: organize the work of inspection teams in accordance with the Earthquake Inspection Plan for corresponding section of the commune, supervise the work of the inspection teams, prepare daily, weekly and final reports for the commune, organize the work of the reinspection teams.

4 Organization of Data Base and Earthquake Damage Data Analysis

The basic data sets on earthquake damage and usability classification, as it has been mentioned before, prepared in three copies, together with the maps and final reports of the inspection teams, sectional and commune headquarters, should be kept in one copy with the commune headquarter and the other two copies should be submitted to the regional and national headquarters or governmental agencies responsible for further actions for reduction of earthquake consequences, evaluation of economic losses and planning of short- and long-term activities for mitigation of seismic risk. Archiving of these three copies of the basic data sets should be carefully done and they should be available for detailed studies and research on earthquake consequences.

All basic data sets should be immediately after their completion transferred to the computer media and analyzed for the first presentation in a form of tables presenting each category of usage and structural type directly associated with the five basic categories of damage and usability in number of buildings and gross area for each section and cumulatively for the commune and affected region as a percentage of the total constructed building area.

Cumulative damage and usability evaluation with the assessed seismic intensities and recorded earthquake ground motions could be immediately presented to the government authorities and the scientific commune in a form of graphs and tables of the evaluated physical damage and concentration of damage within the commune and the affected region.

5 Assessment of Economic Losses

From the completed earthquake damage evaluation and summary analysis of building damage, earthquake damage could be related directly with reference to structural types, usage categories of the buildings, and also gross area. For estimation of economic losses, the first strategic decision should be made on the level to which earthquake damaged buildings should be repaired and strengthened. Two basic decisions are in general possible:

- buildings should be repaired and strengthened to be aseismic structures with possible updated functioning, or
- buildings could be repaired to pre-earthquake conditions. (Many Balkan countries are implementing the first decision because large earthquakes occur often and the stock of non-aseismic construction is large).

After the decision on the basic strategic approach is made, summary relationships on observed damage (empirical vulnerability functions with respect to ground shaking intensity could be prepared for each structural type of the buildings (Figures 1 to 3). Depending on the distributions for each structural type in the total gross area, a number of representative samples could be selected for detailed cost-estimate analysis of repair and strengthening of each category and for at least five levels of ground shaking. For each of the selected sample buildings, detailed analysis of design and detailing should be performed prior to the cost-estimate analysis. Based on the analysis of a sufficient number of selected samples, functions for estimation of the cost for repair and strengthening of the structural system. nonstructural elements and installations, including improvement of the building function, could be developed similarly to those shown in Figure 4 from the Montenegro earthquake. The cost of repair and strengthening could be presented as a percent of the total cost of new construction per unit area.

Once these preliminary tasks are accomplished, summary of direct economic losses on buildings will be rather simple. In addition to building losses, direct as well as indirect economic losses for local and regional infrastructures should be assessed by specialized inspection teams.

To illustrate the assessment of direct economic losses, two examples of the Skopje 26 July 1963 and Montenegro April 15, 1979 earthquakes in Yugoslavia are briefly given with summary presentation of earthquake damage classification on 16.478 residential buildings in three major categories and subcategories of damage (Table 1) after Skopje 1963 earthquake, and earthquake damage classification of the entire stock of 57.640 buildings summarized in 3 basic categories of damage in 6 coastal communes and 6 hinterland communes after 1979 Montenegro earthquake (Table 3) with discrete distribution given in Figure 6. Total direct economic loss assessment by major sections is given in Table 2 and Table 4 for Skopje 1963 and Montenegro 1979 earthquake, respectively. Total direct economic loss is estimated to 15 and 10 percent of the gross national product of Yugoslavia for the year of 1963 and 1979 which was a very serious penalty to the economy of the country. In Table 3, parallel with the direct economic loss assessed, which is anticipated by the Federal Assembly Programme for reconstruction, realization of reconstruction programme is given, and dynamic funds allocation and their realization for the ten years period of reconstruction is presented in Figure 5.

Based on the experience gathered and the studies performed for the purpose of planning of short and long term measures for reduction of the earthquake consequences in major catastrophic earthquakes in the past 30 years, it is well recognized that the efficient planning and implementation of reconstruction programmes could be organized only on the basis of a detailed earthquake damage classification of the affected entire stock of buildings and structures implementing consistent and uniform methodology and procedure. The collected data are of basic importance for the development of the empirical vulnerability functions of traditional types of construction, verification of the experimental and theoretical vulnerability functions of modern types of construction as well as verification and improvement of seismic design codes and regulations. Assessment of the earthquake losses in pre-earthquake and post-earthquake conditions and planning of measures and activities for mitigation of seismic risk and reduction of earthquake consequences will be much more realistic with the implementation of the presented methodology and procedure for earthquake damage classification and loss assessment.

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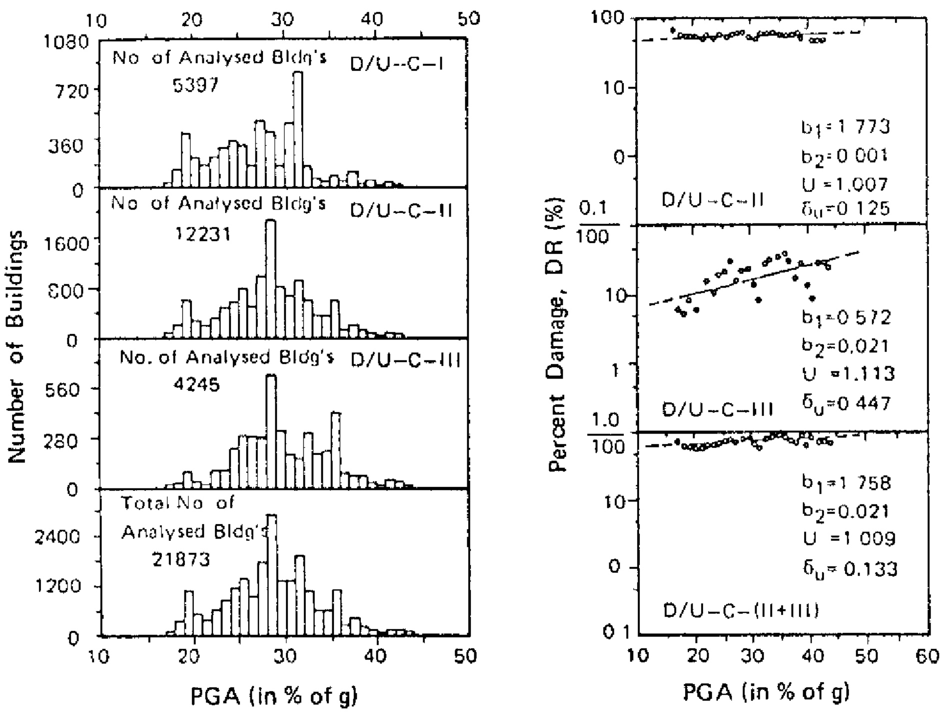

a) Analysed Building Population

b) Data Scattergram and Regressed Vulnerability Functions

Fig. 1. Generalized Physical (Function) Vulnerability Functions and Data Scattergrams for STONE MASONRY (SM) Buildings

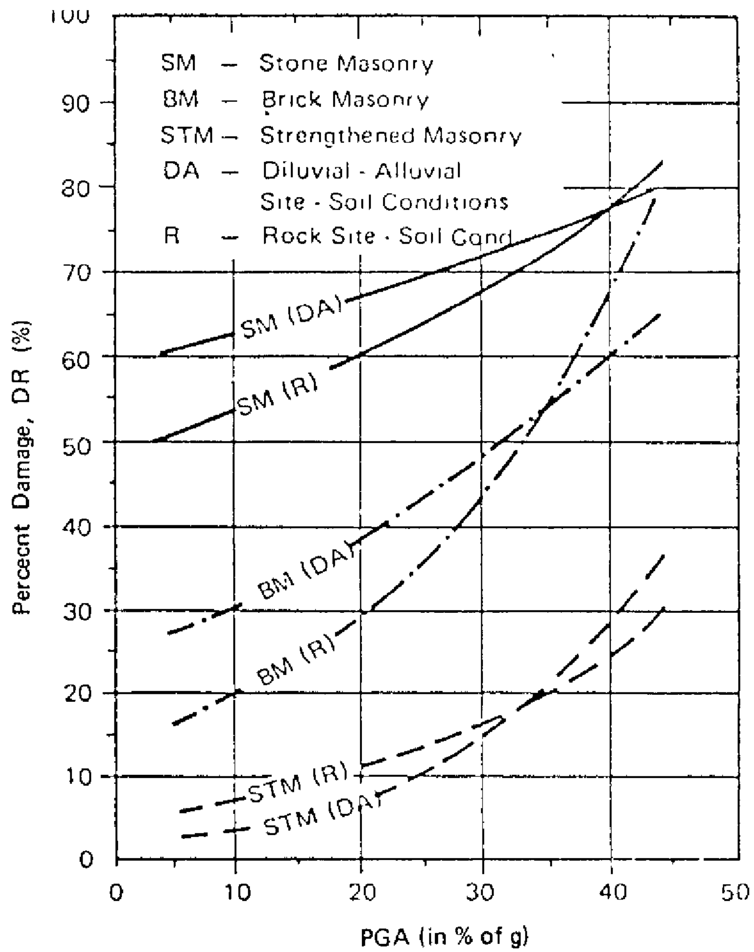

Fig. 2. Site Dependent Vulnerability Functions for D/U–C–(II + III)

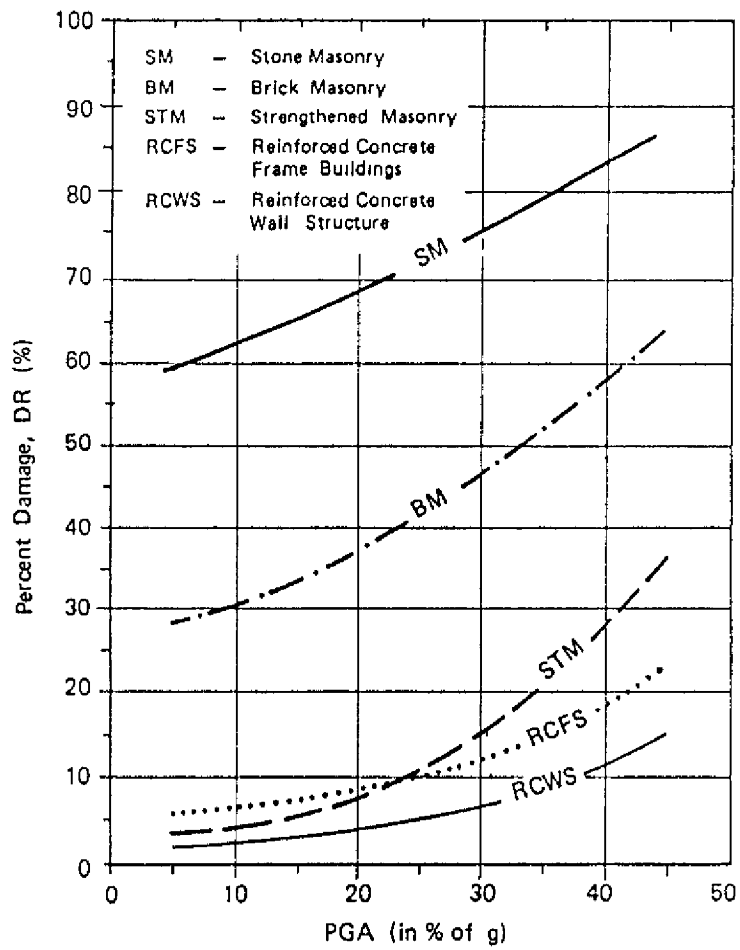

Fig. 3. Vulnerability Functions of Buildings by Structural Types

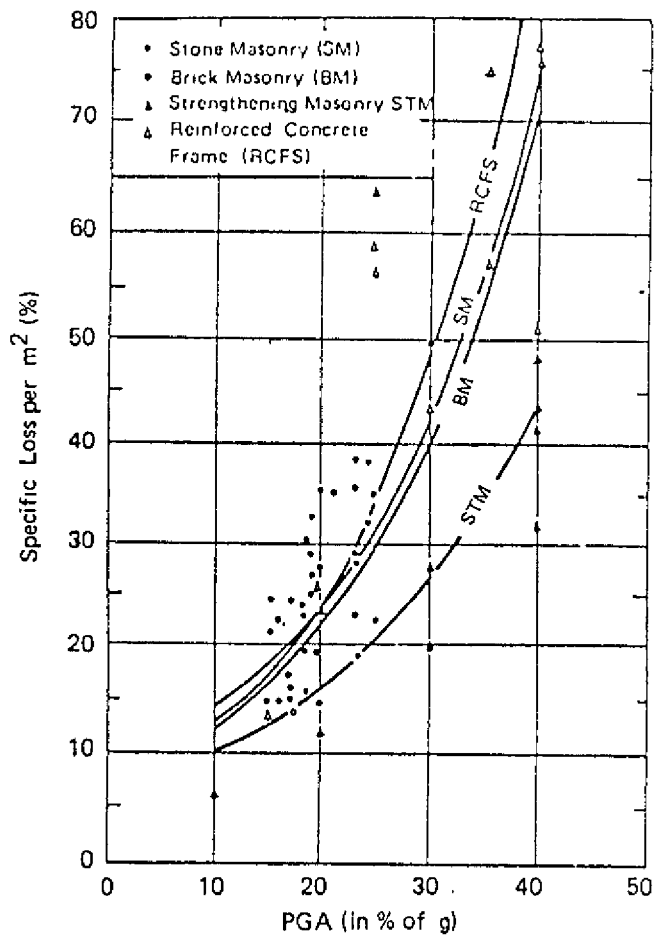

Fig. 4. Functions of Cost for Repair and Strengthening of Earthquake Damage Buildings

Table 1. Summary on Building Damage Data Statistics for Skopje by Damage/Usability Categorization

Commune	Total		Red (D/U-C-III)				Yellow (D/U - C - II)						Green (D/U - C - I)						Non - inspected (Undamaged) Building/dwelling Stock	
			R - II (destroyed)		R - I		Y - III		Y - II		Y - I		G - III		G - II		G - I			
	NB	ND	NB	ND	NB	ND	NB	ND	NB	ND	NB	ND	NB	ND	NB	ND	NB	ND	NB	ND
Idadija	4093	12684	342	1156	1212	2954	35	124	1331	5206	84	552	452	1107	164	756	70	137	403	692
Kale	4737	7235	975	1242	2892	4305	81	139	602	1176	86	98	32	43	37	159	32	73		
Kisela Voda	3854	8908	218	371	956	1458	14	156	890	2624	36	177	1724	3910	15	211	1	1		
Saat Kula	3794	6199	327	442	2210	2843	-	-	460	1268	13	17	169	610	7	16			608	1003
Total for Skopje	16478	35026	1862	3211	7270	11560	130	419	3283	10274	219	844	2377	5670	223	1142	103	211	1011	1695
Percentage	100	100	11.3	9.2	44.1	33.0	0.8	1.2	19.9	29.3	1.3	2.4	14.5	16.2	1.4	3.3	0.6	0.6	6.1	4.8

NB – Number of damaged/inspected buildings
ND – Number of damaged/inspected dwellings
Y–II Yellow (Y) two (II) strokes

Table 2. Funds used for reconstruction of Skopje in the period 1963–1973

		Anticipated with Programme for 1963/73 000 Din	% of Total	Realized in the period 1963/73 000 Din	Realization in %
	TOTAL :	6.190.000	100	6.105.000	98 6
1	Facilities of the Yugoslav Army	339 000	5.5	339 000	100.0
2.	Economy	1.832.500	29 6	1.755.134	95.8
3	Residence	1.009 000	16 3	1.003.879	99.5
4.	Main public services	733.000	11.8	733.000	100.0
5.	Public buildings of SRM	415.000	6.7	415.000	100.0
6.	Public buildings of the city	1.369.500	22.2	1.368.498	99.9
	6.1. Public utilities	621.765		621.765	100.0
	6.2. Education	436.748		429.912	98.4
	6.3. Culture	118.814		130.910	110.2
	6.4. Physical and technical culture	61.828		53.826	87.1
	6.5. Health care and social welfare	69.145		69.145	100.0
	6.6. State bodies and organizations	61.200		62.940	103.0
7.	Preparation of construction sites	290.000	4.7	290.000	100.0
8.	Compensation to banks and funds for loans cancelled due to the earthquake	145.000	2 3	145.000	100 0
9.	Fund expenses	34.000	0.5	32.489	92.6
10.	Fund reserves	23.000	0.4	23.000	100.0
	10.1. Economy	7 000		7.000	100 0
	10.2. Public utilities	11.000		11.000	100 0
	10 3 Education	5.000		5 000	100 0

12,00 dinars = 1 USA $

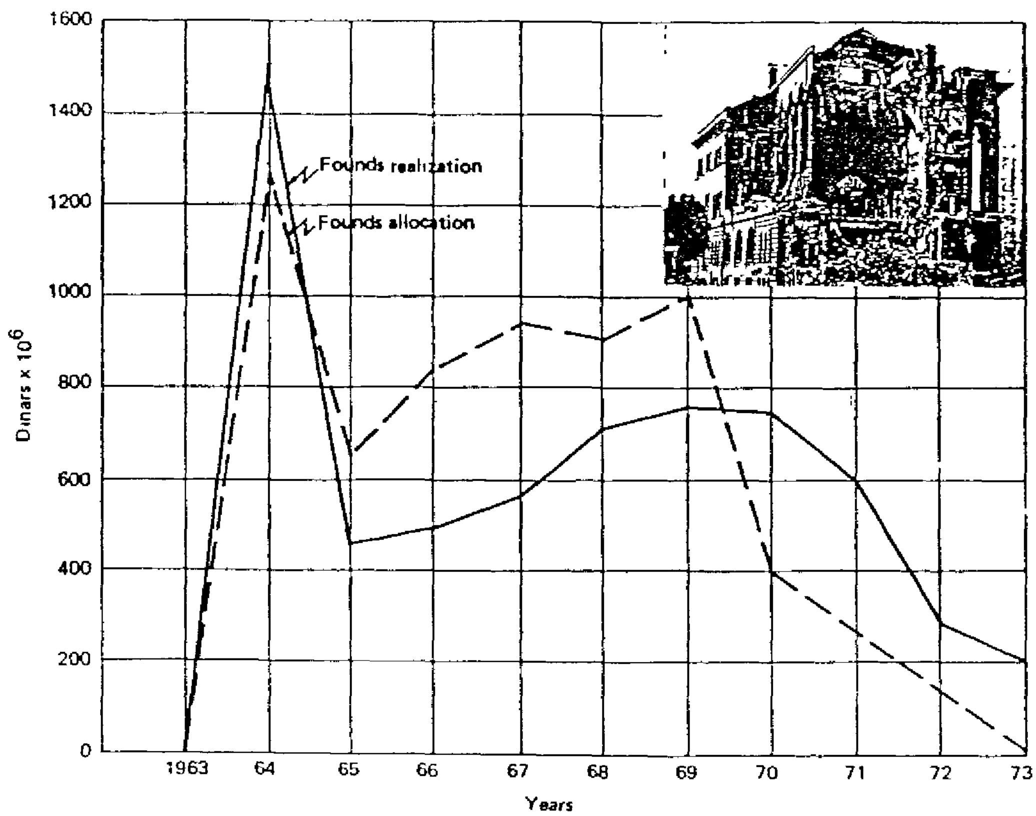

Fig. 5. Dynamic of Founds Allocation and their Realization in the Reconstruction of the City of Skopje in the Period 1963 – 1973

Table 3. Classification of Damaged Buildings in Six Coastal and Hinterland Communes

Commune	Damage Level: Non Damaged No Bldg's	%	To Be Repaired No Bldg's	%	To Be Demolished No Bldg's	%	Total No Bldg's	%
Coastal								
ULCINJ	2 424	36	1 119	17	3 183	47	6,726	100
BAR	4,595	47	1,887	17	3,870	36	10,357	100
BUDVA	1,496	59	496	19	565	22	2,609	100
TIVAT	2,049	69	526	18	406	13	2,962	100
KOTOR	3,621	56	1,425	22	1,435	22	6,482	100
H NOVI	3,601	63	1,221	21	915	16	5,737	100
Hinterland								
CETINJE	2,955	43	2,451	35	1,556	22	6,937	100
NIKŠIĆ	2,490	74	620	18	276	8	3,315	100
TITOGRAD	4,971	83	891	15	116	2	5,826	100
DANILOVGRAD	4,207	80	869	17	181	3	5,237	100
IVANGRAD	649	88	84	12	2	0	735	100
KOLAŠIN	498	69	184	26	35	5	717	100
TOTAL	33,556	58	11,773	20	12,540	22	57,640	100

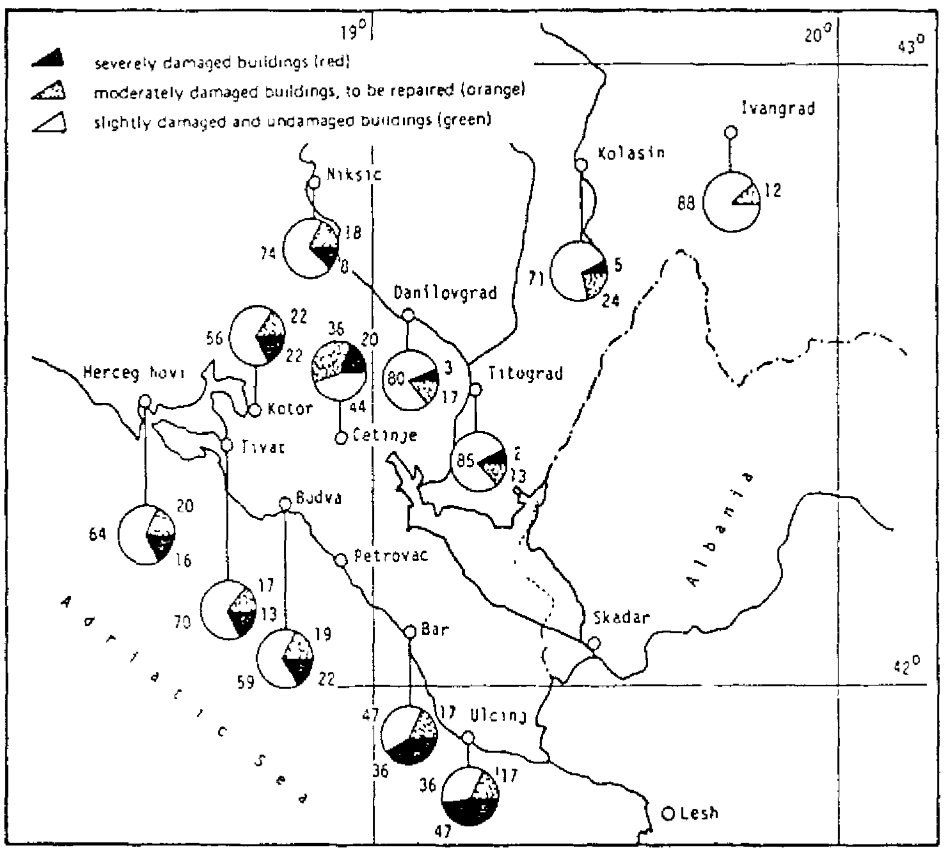

Fig. 6. Discrete Distribution of Damage in the Communes of SR Montenegro dut to the Earthquake of April 15, 1979

Table 4. Total Losses Caused by April 15, 1979, Montenegro Earthquake

Activities	Direct Losses 000	%	Indirect Losses 000	%	Total 000	%
A Economy	16,277,158	77.27	4,787,837	22 73	21,066,000	29.80
1. Industry	3,352,654		1,049,926		4,402,580	
2 Transportation	4,329,412		924,794		5,254,206	
3. Trade	1,389,547		514,876		1,904,423	
4 Tourist Industry	4,714,369		1,918,110		6,532,479	
5. Other Activities	2,491,176		380,131		2,871,307	
B Public and Social Services	10,948,886	98.80	132,653	1.20	11,081,539	15 70
1. Education,Science,Culture	1,718,381				1,718,381	
2. Health and Social Welfare	744,303		132,653		876,956	
3 Socio-Political Organizations	8,486,202				8,486,202	
- Residential Stock, only	2,971,312				2,971,312	
C Private Sector	21,958,946	100.00			21,958,946	31.07
- Residential Stock, only	14,956,107				14,956,107	
D Expenses of Socio-Political Organizations	3,911,615	100.00			3,911,615	5 53
E Cultural and Historic Heritage	10,499,223	100.00			10,499,223	14.85
F Property of JNA	2,158,789	100.00			2,158,789	3.05
GRAND TOTAL	65,754,616	93.09	4,920,490	6.91	70,675,106	100.00

17,83 YU Din. (1979) = 1US$.

Table 5. Spatial Distribution of Losses

Zone	Damage Value and Percent x10⁶ YU Din	x10⁶ US $	%
I Zone Montenegro Coast (6 Communes)	54,663	3,065.8	77.35
II Zone Central Part (4 Communes)	11,953	670 4	16 91
III Zone Northern Part (10 Communes)	1,744	97.8	2.47
IV Losses Of JNA	2,158	121 1	3 05
V Expences of Socio – Political Organizations	155	8.7	0 22
TOTAL	70,675	3,963.8	100.00

EARTHQUAKE RECONSTRUCTION FOR FUTURE PROTECTION

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Six principles of turning reconstruction into protection against future earthquakes:

1. Use the Reconstruction for Economic Recovery
2. Ensure Cultural Continuity in the Reconstruction
3. Deconcentrate Cities and Services
4. Instigate Safe Construction Procedures (Not Just Safe Buildings)
5. Institutionalize Safety Culture
6. Export Improvements Beyond the Reconstruction Area

1. Use the Reconstruction for Economic Recovery

Economic regeneration is the key to successful reconstruction: restore income as well as buildings. A strong economy is the best protection against future earthquakes. A strong economy means more money to spend on stronger buildings and larger financial reserves to cope with future losses.

Identify the weakest members of the economy. Those who have lost their economic reserves (house, livestock, livelihood) and ensure that assistance reaches them. Marginal families without reserves can quickly become destitute. Migration of families from rural areas to the towns is accelerated by earthquake losses.

Recovery of Agricultural Economies

Understand the market structure of the region - what is normally produced, how much is sold or consumed by the community itself, where produce is sent to market, the supply and distribution network and how the earthquake has affected the market process. Recovery should ensure both the continued supply of produce to areas outside and to revitalize the livelihoods of farmers within the earthquake-affected area. The earthquake has destroyed reserves that farmers' use to survive poor harvests and bad times: replacement of these reserves is needed for full recovery. Identify the most economically vulnerable members of the community and target aid towards them. Help replace animal losses, tools and seed. Instigate programmes of income supplementing, (bee-keeping, dairy processing, craft production).

Revitalizing Industrial Economies

Infrastructure is critical to industry: repair this first. Promote a partnership between private sector and government. Smaller companies are likely to be under-insured and may be unable to recapitalize and continue in business even if profitable. Look at the government-imposed restrictions on industry - e.g. locational zones, pollution controls, labour laws etc. in the emergency is it possible to remove them or relax them during the reconstruction period? Industry is interdependent - look at linkages between factories and where their employees live - is housing damaged as well as their income?

Recovery of Commerce and Service Industries

Service industries, (shops, small businesses and trades) provide employment and income to a large proportion of the population. Premises are vital to continuity. Provide temporary (lockable) structures for use during emergency and rehabilitation phase. Loss of customers is the biggest damage caused by earthquake. Restore communications and information linkages between customers and businesses: Newspapers, Radio, TV for trade information dissemination.

Central Business Districts tend to be located where they are for very specific reasons of trade routes and proximity to markets. Unless the earthquake has changed these basic factors, the CBD will repair itself - damaged buildings form only a small part of the office costs (staff and operating overheads far exceed structural costs of office buildings). Communications and utlities are vital to the early recovery of CBD.

Recovery of Tourism

Negative publicity associated with earthquakes can harm short term tourism returns. An effective and efficient reconstruction programme can be used to counter negative publicity with positive images of recovery and improved facilities. Past examples in other countries (Italy, Greece, Yugoslavia) include making the reconstruction and restoration of earthquake damage into a tourist attraction in its own right. Public relations and tourism marketing should be seriously considered, running promotional campaigns for the region in the main places that tourists come from.

Construction Industry and Building Materials Manufacture

The construction industry is a primary employer in the region and reconstruction operations is a good method of injecting capital into the local economy: local building labourers spend their wages in the local shop - both shop and local labourer benefit.

Use an expanded local building industry for rebuilding - use outside contractors as little as possible, and in partnership with local companies. A strong local construction industry is a good protection against future earthquakes.

Develop an Integrated Building Materials Plan: use locally manufactured building materials as much as possible, regional materials if necessary and imported materials as little as possible. Examine the materials market and normal production levels. Consider expanding local material production in preference to using materials from elsewhere. Consider substituting materials for local equivalents, even if these are currently poorer quality (use technical assistance to improve quality). Small scale manufacturing processes are quicker to set up and expand than large-scale, and distribute investment more rapidly to the local community.

2. Ensure Cultural Continuity in the Reconstruction

Many examples of reconstruction have failed through assistance being insensitive to local needs and preferences. Relocation and bad reconstruction decisions can cripple the local economic productivity of a settlement and render it more vulnerable in the future.

<u>Relocation of settlements should be avoided wherever possible.</u>

Most settlements are where they are for a reason and it is rare that the threat of future hazard outweighs those reasons. Earthquake damage alone rarely justifies resiting. Major landslide or flooding threats may.

Rehousing in buildings that are different to those normally built by the community for themselves will generate long-term problems: they may quickly become unpopular and investment will be wasted. <u>Do not provide housing: make housing happen.</u> Facilitate the normal housing operations and help the local construction industry expand to meet the demand.

Radical agricultural reforms, like farm collectivizations and major land reforms instigated following earthquakes have rarely been successful.

<u>Decisions on reconstruction should be taken at the most local level possible.</u>

3. Deconcentrate Cities and Services

An earthquake also presents an opportunity to reappraise physical fabric and urban services. A key strategy for future earthquake protection is to deconcentrate facilities: <u>Services provided by one central facility are always more at risk than those provided by several smaller facilities.</u> This principle applies equally to hospitals and campuses, for example, as it does to power stations, telephone exchanges, and water treatment plants. Where damage has been suffered by a facility, rebuild it as a number of smaller units, preferably spread out over an area, rather than as a single unit or in one place.

Similarly, densities of cities may be reappraised in the reconstruction planning. Lower densities can be encouraged by the morphology of urban areas: the area and distance between streets, plots of land made available and in allowable plot ratio developments.

4. Instigate Safe Construction Procedures

Earthquakes will continue to occur long into the future. It may be a long time before such a destructive earthquake hits the same region again, but it is likely to happen. The region is likely to continue to experience lower intensities fairly frequently.

The next time that Baguio or Dagupan is hit by such a large earthquake may be a century or more away. The steps that are taken to restore the towns and region now must be capable of providing proper protection to the region in that future time, as well as against the frequent tremors it will experience in the meantime.

Some of the buildings built in today's reconstruction will still be around for the next big earthquake, but not many. Buildings that last for 20, 50 or even 100 years will be replaced by others. The earthquake reconstruction must be used to instigate safe construction procedures that will continue for the next century. Just building a set of stronger reconstruction buildings will not be enough if the buildings built later on are as weak as the ones built before the earthquake.

Procedures for a stronger building stock include strong quality control and building code compliance checks. The method of checking and enforcing building standards has to be firmly instigated in a new process that cannot be easily revoked. Quality control needs trained engineers. Municipal engineers are the front-line troops in future earthquake protection. Engineering design and training may be reviewed as part of a wider strategy for implementing better construction procedures.

Non-engineered buildings form the highest percentage of the building stock in every region. Improving the process of producing safer non-engineered buildings involves training the builders that produce them. Education processes have to be designed specially for them: practical hands-on training is more effective than audio-visual material or books.

5. Institutionalize Safety Culture

In a 'Safety Culture', people take accoubt of day-to-day risks they face in their normal decision-making processes: special earthquake-risk programs are not needed to make it happen.

Public awareness of risk levels is the first step. Public education on risk should be integrated within normal TV programmes, newspaper articles and entertainment rather than as public service announcements. All profession training of engineers, planners, architects, public officials etc. should include earthquake risk as a module.

Planning decisions, building design, road construction and economic strategies should take earthquake risk into account as a normal part of the factors under consideration. Basic ground rules need proposing for risk minimization in each profession.

6. Export Improvements Beyond the Reconstruction Area

The next earthquake to hit the Philippines is unlikely to happen in the same place. It may occur on another part of the same earthquake fault, further north, or further south, or on another fault system in Luzon, or on another island. To reduce the impact of that event, the full lessons of the Luzon earthquake and the improvements that are instituted in the reconstruction have to be implemented outside the damaged area.

The national institutions responsible for hazard mitigation have to be built up and maintained.

A national risk mitigation plan will identify the areas most at risk from future earthquakes and propose strategies to reduce it. Risk identification involves mapping hazard and future earthquake occurrence, looking at where that hazard threatens major settlements and infrastructure, and how vulnerable the elements are to earthquake occurrence. Public awareness, training, reassessment of investment strategies, deconcentration and safe construction procedures can then be implemented in these areas to ensure that future earthquakes in the Philippines do not pose the same threat to life and economic prosperity as the earthquake of 16 July.

REGIONAL PLANNING ISSUES IN EARTHQUAKE MITIGATION

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Seminar Notes

Strategic Planning in Regional Context

* Increase speed and efficiency of reconstruction and recovery

* Guide reconstruction to reduce future vulnerability to earthquakes

* Promote development

Objective: Develop sustainable, efficient system of human settlement and activity with minimum vulnerability to earthquake

Alternative Perspectives in Response to Earthquake Damage

* Restore situation to status quo as it existed before earthquake

* Build completely new without concern for what was in place before earthquake

* Rebuild taking advantage of opportunity to improve on situation that existed before the earthquake

Evolution of Regional Systems

* Important to use local knowledge (even before earthquake local residents had ideas of how situation might be improved)

* Facilitate and support on-going processes

* Improve situation to remove differences in quality of life and standards of living

Regional Development Strategies to Minimize Impact of Future Earthquakes: Reducing vulnerability of critical lifeline and economic support systems

* Strengthening key elements

* Decentralizing key functions

* Restructuring systems to avoid risk

Regional Development Processes

* Increase per capita productivity

* Increase savings and investment

Basic Factors

* Generation of employment (Division of labour)

* Integration of local economy

* Linkage with external markets

Hierarchy of Function Among Urban Places

* Economies of scale

* Economies of agglomeration

Sustainability of Development

* Analyze how existing systems failed in earthquake

* Determine what can be done to rebuild so that the systems will be less vulnerable in the next earthquake
  - access roads
  - bridges
  - railways
  - telecommunications
  - power
  - water
  - waste disposal
  - telex
  - food supplies

* Assess environmental impacts to ensure no long-term degradation
  - erosion
  - recharge of aquifer
  - river siltation
  - water pollution

Efficiency of Development

* Provide regional system to support economic activity
  - encourage evolution of economic system
  - avoid building old problems back into system

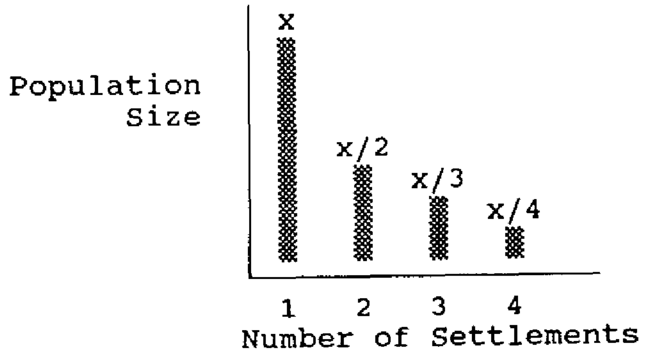
* Build intra-regional systems
  - infrastructure
  - industry and services
  - production and markets

* build inter-regional systems
  - drainage and pollution control
  - tourism
  - education
  - agriculture
  - industry
  - watershed capacity

Methodology of Regional Analysis

* Determine population change over time
  - size
  - demographic characteristics

* Determine population nature and dispersion
  - index of concentration
  - Lorenz Curve
  - Gini Coefficient
  - rank and size of population centers (opportunity loss analysis)



* Combine projections of changing regional structure
  - environmental
  - demographic
  - economic

* Design strategy to facilitate transition to sustainable, efficient development program.

Appendix IV

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