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III. B. 1. DETAILED STOCKTAKING

1. PROCEDURES AND METHODOLOGIES

1.1. The General Handling of Stocktaking

During our presence in Armenia the mission concentrated on the disaster potential associated with earthquakes, flood and inundation, landslides, mudflows and industrial accidents. It is, however, evident that these categories of hazards do only represent part of the total exposure potential. As it is for many reasons not at all economic to segregate stocktaking according to the natural and industrial hazards and the elements at risk, a comprehensive approach is strongly recommended. Evidently groups of experts will have to deal with individual hazards but when analysing the elements at risk a unified approach is recommended. Even the hazard assessment should be carried out under the guidance of integrating research management in order to achieve, for instance, a common philosophy and doctrine. Unless this is achieved results cannot be compared and integrated.

In order to illustrate the general approach and the methodology of stocktaking the following introductory discussion will try to illustrate the general problems.

As data and information collected during stocktaking is of vital importance not only in connection with the natural hazards and industrial accidents one should first attempt to prepare a list of potential hazards as complete as possible. In general one can approach the disaster potential from different risks with the help of the following algorithm:

$$DP = f\,[H_g(W, S, E, Ts, V, G, F, Ex, Tr, M, A, PL, EC, B, Te, Ag, Ep, H_r \ldots)] \qquad (1)$$

The symbols have the following meaning:

- DP = Disaster Potential
- f = function of (...)
- H_g = General Human failure potential
- W = Hydrological group of perils (Flood, Inundation, Groundwater)
- S = Windstorm & Hailstorm
- E = Earthquake
- Ts = Tsunami (Seaquake)
- V = Volcanism
- G = Geological group of perils (slides, rockfall, settlement, expansive soils)
- F = Fire
- Ex = Explosion
- Tr = Transport accidents (on land)
- M = Transport accidents (marine)
- A = Aviation accidents
- PL = Product Liability
- EC = Environmental Contamination
- B = Burglary, Robbery
- Te = Terrorism
- Ag = Agricultural problems (desertification, salinity, fertility, pests. diseases,...)
- Ep = Epidemological problems
- H_r = Residual Human failure potential

In connection with each of the above risks the relative importance must be determined because

$$X = p \times DP \qquad (2)$$

that is, the impact of the respective risk (X) is the product of the Disaster Potential (DP) and its probability (p). When evaluating the impact of a disaster on a country or its economy, the result obtained from this formula must, however, be critically weighed as will be illustrated by an example.

We shall illustrate this issue utilizing earthquake exposure which is a very prominent risk in Armenia. We assume that the relative importance of two different earthquake scenarios are to be assessed. In one region the earthquake probability is relatively high but the population density is not great, whereas in a different area the earthquake probability is small, the number of people living in this region is, however, considerable.

We assume that in the first region the return period of an earthquake of a given magnitude, intensity, or ground acceleration is about 250 years, corresponding to an annual probability of 0.4%, and a population of 100,000 would be affected. The above formula would yield

$$X = 0.4 \times 200,000 = 80,000$$

In the second region the probability is only 0.1% (R [return period] = 1000 years). Because of a large city this earthquake would affect 1,500,000 people. (We tacitly assume that the vulnerability of the two regions is identical.) We now calculate

$$X = 0.1 \times 1,500,000 = 150,000$$

It would not be correct to assign the same relative importance to disaster preparedness, prevention, and management to both regions. The quantum of loss in the first region is only about 53% of the one in the second region but the country as such and its economy would be much more affected by the earthquake in the low seismicity region than by one in the other one. In an extreme case the chance of the countries' recovery could be jeopardized. On the other hand one cannot base priority assessments on the magnitude of loss only (1,500,000 compared to 200,000 in the example selected) and to disregard event probability. There are no hard and fast rules assisting in such decisions, in particular as the overall scenarios will never be identical. Therefore each scenarium must be evaluated individually in order to prepare a proper basis for decisions. Such decisions will also depend on the upper acceptable catastrophe limit.

A somewhat different approach is based on the risk rate (X) in permille (%o).

$$x = \frac{LE \times f \times u \times P \times 1,000}{R \times V} \qquad (3)$$

That is, the risk rate X (%o) is the product of the Loss Expected (LE) times the overhead factor (f), times the uncertainty (u) which can be considered a safety factor, times the period of exposure (P = years), and divided by the return period (R in years) and the value at risk (V).

To be able to perform such a calculation, or the one using formula (2) one must be able to establish the damage probability distribution, i. e. the correlation between the various damage levels and their respective probability and the corresponding return periods. This shows that more is needed than the vulnerability function. Moreover, the event probability distribution must be known, i. e. the correlation between event magnitudes (earthquakes, floods, wind velocities, etc.) and the pertaining return periods. In addition the uncertainties in these assessments must be established because it would amount to an error of catastrophic magnitude not to allow for proper safety factors when assessing disaster potentials.

Formula (3) provides the risk rate but, like formula (2) no assistance in weighing the relative importance of an exposure. This must be decided on a case by case basis. It should, however, be noted already at this place that the geographical distribution of elements at risk in Armenia requires a very careful evaluation particularly in the region of Yerevan.

Formula (1) which should not be considered as describing all perils which may cause a disaster or contribute to one, still shows that the spectrum of perils is very wide. This means that it is advisible when starting a project of stocktaking aimed at disaster evaluation and mitigation, etc., to select those perils which are to be considered of primordial importance.

In addition the author suggests to start stocktaking with a pilot study concentrating on a natural hazard of great importance the handling of which is not too difficult and which therefore guarantees quick and satisfactory progress. The main reason for this suggestion is that even the handling of a single peril is a formidable management and organisational task which requires the co-operation of many parties and professionals. In addition much effort must be invested in the training of local personnel. All this intrinsically involves a multiple learning phase and it is therefore more economical to concentrate efforts and to achieve results soon instead of trying to tackle many perils at the same time without the benefit of a learning phase

The author therefore suggests to address attention first to the disaster potential from earthquakes. In this field much basic information is already available and the work to be done is not too complex. It requires the training of suitable personnel which can, however, thereafter be used efficiently for other perils after having received some additional material, information and training.

This does not mean that other perils like hydrological or industrial ones or landslides are to be disregarded for the time being. Quite to the contrary, in addition to the pilot stocktaking project in the field of earthquake risk, it is advisable to prepare at least a preliminary basis for a detailed stocktaking of flood and inundation, landslides as well as of the industrial disasters, along with the collection of the material needed for earthquake risk analysis.

2. 2. Management and Organisation

As will be shown in the section discussing specific tasks related to earthquake stocktaking, it will be necessary to deal with problems, data, and information pertaining to different fields and to involve people of different professional background and qualifications. When discussing the specific tasks to be dealt with in the fields of earthquake stocktaking, recommendations will also be made as regards number and qualifications of persons required. We shall therefore deal in this section only with general issues.

The office entrusted with stocktaking is for intrinsic reasons responsible for preparing a reliable basis for the assessment of future catastrophes and therefore for the basis on which decisions will be founded. Because earthquake disasters, for instance, can amount to a regional and even national catastrophe, this office must be given adequate powers and facilities to recruit the co-operation of specialists needed and in general it must have adequate staff and facilities to take care of all administrative and managerial work. This office should be able to work as unimpeded as possible. It should also be suitably vested to ensure that the necessary steps are introduced and carried out.

Moreover, it must be appreciated that stocktaking being the basis of disaster preparedness, prevention, and management is not a temporary project which ends when assessment, evaluations, recommendations, safety standards, etc. have been elaborated, but which must continue in the face of constantly developing and changing disaster scenarios.

Such an office will have to recruit specialists from many fields and will need assistance from different Government departments, academies and professional associations. As regards experts, in particular the following specialists will have to be involved at some stage of the project: Seismologists, meteorologists, hydrologists, geologists, cartographers, earthquake engineers, civil engineers, mechanical engineers, electrical engineers, chemical engineers, industrial engineers, doctors of medicine, economists, publishing & printing.

This shows that an organogram with pertaining job descriptions should be elaborated at an early stage. At the same time a list of the faculties, persons, and associations the help of which may be required at some stage should be compiled. Moreover, it is suggested that a senior adviser is appointed who is familiar with the different important fields. His duty would be to ensure a coherent, complete and efficient stocktaking. In the present world of overspecialization and conflicting aims the role of such a person cannot be overestimated.

1. 3. Earthquake Stocktaking

1. 3. 1. Seismicity

Earthquake risk zoning maps have been developed and used in Armenia for many years for developing building standards, rules and codes. It is the well-considered opinion of the author that these maps should be refined. For instance the presently used seismicity indication as an index to the intensity is too crude as it indicates return periods of 100, 1,000, and 10,000 years. Moreover these maps do not consider seismic gaps, i.e. regions with an enhanced probability of earthquake occurrence.

Therefore it is suggested to refine these maps and to consider the method developed by the author many years ago for the Swiss Reinsurance Company, Zurich (cf. section on Seismicity). The method which is for the convenience of readers briefly presented also in this section (cf. also section III. A 1.) is based on seismic indices (SI). It can be used to calculate return periods for selected earthquake intensities, damage levels, magnitudes, and accelerations.

Whereas such a formalistic approach may be somewhat too complicated for incorporation in a general earthquake zoning map and a building code, it is very useful for general exposure assessment and in specific cases for deciding on design criteria for very valuable projects, as this is impossible on the basis of standard earthquake maps and codes. Moreover, the decision which code level and sophistication is to be selected should be based inter alia on such a formalistic approach. It is stressed that modern earthquake building codes similarly provide for the use of models of different sophistication.

The calculations mentioned above are based on Seismic Index Maps (SIM) developed and refined over the years by the author. The most modern version of this map will be available within some months but one of the maps showing the Caucasian region is contained in the section dealing with seismicity.

The Seismic Indices (SI), i.e. the seismicity of a region is derived from the instrumentally recorded earthquakes. Seismic gaps and seismic trends must be considered as discussed under Seismicity.

In order to illustrate the approach and some additional problems we shall calculate the return periods for two categories of buildings.

1. Brick Buildings:

It can be derived from Fig. 1 in the section dealing with earthquakes (cf. III. A. 2. Earthquakes) that the Mean Damage Ratio (MDR) of brick buildings which are founded on medium-hard alluvium is about 54% of their new replacement value if the earthquake intensity is approximately MM VIII or MSK VIII. From Fig. 6 in II. A. 1. it is seen that the effective area is about 300,000 km² for MM VIII. The basic formula is:

$$R_{MM;\,MDR} = \frac{A_{count}\ n_g\ OP}{f_G\ f_T\ f\ \ SI\ \ A_{eff}} \qquad (4)$$

The SI is assumed to be 0.3. How the SI is interpolated from the SIM and how corrections for seismic gaps, seismic trends, and safety factors are selected should be shown during a future training programme when preparing the local experts for the coming steps of the stocktaking project. We shall therefore perform the following calculation without any correction factor, i.e. assuming f_G, f_T, and f to be equal to 1. We now calculate

$$R_{MDR = 54\%} = \frac{125{,}000 \times 17.74 \times 90}{1 \times 1 \times 1 \times 0.3 \times 300{,}000} = \text{abt. 2200 years}$$

It must be stressed that the MDR of 54% holds only for moderately asymmetrical buildings which are founded on medium-hard alluvium. Therefore the MDR will be substantially higher for brick buildings founded on soft and deep alluvium with a high groundwater level as existing in the valleys of Armenia. A penalty of one intensity step would raise the MDR to about 86%. On soft alluvium a MDR of about 50% can be produced already by MM VII. As the effective area is about 1.3 million square kilometers for MM VII the return period for such damage on this subsoil is only 550 years. This shows that seismicity stocktaking cannot be seen in isolation and it underlines the need for someone with a good understanding of all parameters to guide the project.

2. Reinforced Concrete Buildings:

The survey carried out by the author in the region of the Spitak earthquake and in Yerevan showed that the earthquake resistance of such buildings is rather low.

We shall therefore select the RC 2-3% g - graph in Fig. 1, but we stress that this graph is valid for monolothic frames and good material and workmanship (cf. III A. 2. Earthquakes, Quality of Design and Quality of Workmanship).

For an intensity of about MM VIII the MDR of such buildings of moderate irregularity founded on medium-hard alluvium is about 28%.

The effective intensity area for such buildings and MM VIII is about 300,000 km². A calculation as before produces

$$R_{MDR = 28\%} = \frac{199{,}575{,}500}{0.3 \times 300{,}000} = \text{abt. 2200 years}$$

For buildings on soft subsoil the MDR would, however, be 52%, provided the sutiation is not aggravated by resonance between subsoil and buildings. Such resonance (cf. III. A. 2. Resonance) would further increase the MDR in the zone of soft alluvium.

The above calculations were not only performed to indicate damage probabilities for common buildings but to illustrate that a number of factors must be considered when determining the exposure of buildings. They demonstrate that a circumspective approach and guidance is needed.

1. 3. 2. Maps of Surface Geology

It has been shown above when calculating return periods for various MDR's of buildings of different earthquake resistance, that the subsoil determines the damage level in a decisive way. The influence is even more complex than mentioned earlier. Therefore good and detailed maps of the surface geology should be available for proper stocktaking.

These maps should not only show the geographical distribution of geological material of different nature but cross-sections through the main regions of larger towns showing the location and depth of the respective layers and lenses down to firm rock. Moreover as much information as available on groundwater levels should be entered in this map or a special one.

Such information is required to assess exposure levels not only because of a generally adverse influence of soft subsoil on earthquake damage but because of problems related to site effects, resonance between buildings and subsoil, and liquefaction.

These maps will also form the basis of microzoning.

1. 3. 3. Maps for entering the Distribution of Buildings according to their Vulnerability and Value.

Good maps of a scale detailed enough to permit recording of the essential parameters which influence the damage potential must be procured or prepared. The scale of these maps should be such that per-city-block-details like: Type of buildings (building material, symmetry & irregularity, number of floors), values, and number of occupants can be entered. The result of the inspection of the individual buildings should be entered in a computer-compatible form like the one appended. (This map is also needed when studying the disaster potential from other causes.)

1. 3. 4. Statistics on Population

It should be checked whether Government or Municipial agencies have statistical data on the population per region and of the different parts of towns. Such data is essential in the assessment of the impact of an earthquake. If official data is not available it must be developed from the data compiled during the stocktaking. (This information is also needed in connection with other causes of disasters.)

1. 3. 5. Maps of Utilities, Life-lines, and Hospitals

The consequences of an earthquake also depend on the vulnerability of such elements at risk. Therefore it will be necessary to prepare a map or maps showing: Powerplants and sub-stations, power distribution system, water supply utilities and the main water supply system, sewer treatment plants and main sewer system, telephone exchanges, bridges, tunnels, subways, airports, ports, location of hospitals. (Data also needed in connection with other hazards.)

1. 3. 6. Maps of Chemical plants

Earthquakes can not only cause serious damage to such plants but trigger substantial environmental problems because of fires, explosions, release of toxic material, and failure of technical equipment. It is therefore essential to prepare a map showing the location of such hazardous plants, their products and by-products. (This map is also needed in connection with stocktaking of industrial disasters caused by other hazards.)

1. 3. 7. Map of Probability Distributions of Wind Speed and Direction

This map is essential when studying the potential of the effects to the vicinity and environment caused by a damaging earthquake or by other accidents affecting industrial plants.

2. Training

During the period of the compilation of the maps, information and data required for further work as outlined above, a panel of persons/experts should be nominated which can be trained by one or several specialists and the senior consultant.

The members of this panel will be responsible to carry out the detailed stocktaking of buildings, factories, utilities, hospitals. Therefore experts in the field of seismology, building engineering, civil engineering, mechanical engineering, electrical and chemical engineering are required. As buildings and civil engineering structures constitute the vast majority of the elements at risk, the number of experts in this field should not be too small to ensure a reasonably fast progress. As a rule of thumb, a team of about 5 experts should be available for a population of 1 million in the epicentral area.

It is suggested to include some additional junior members, like students and/or young engineers, as it will be necessary to distribute duties and take care of additional tasks. Such juniors are also required to ensure continuity. Moreover, at least one medical expert should be included who could later concentrates on the problems of medical facilities required in case of catastrophes.

After the material mentioned earlier has been compiled and the personnel has been nominated it is suggested to carry out a training course. During this course the participants would be familiarized with the method of stocktaking and important parameters controlling damage to buildings, civil engineering structures, factories, chemical plants, and life lines. This will enable them to fill the forms reliably. Visual aids should be employed to render this phase of the training as efficient as possible. The participants should also receive sets of technical and scientific literature.

The training course should elaborate on:

- Criteria and errors of seismicity determinations
- Resonance between buildings, technical equipment and subsoil
- Influence of foundation material (site effects)
- Shear strength of buildings
- Influence of building materials on vulnerability
- Regularity and symmetry and their influence on vulnerability
- Non-structural elements and their influence on damage
- Orientational sensitivity
- Vulnerability of civil engineering structures
- Vulnerability of mechanical engineering facilities
- Vulnerability of electrical items
- Vulnerability of items found in chemical plants
- Vulnerability of pipe lines
- Vulnerability of telephone systems
- Vulnerability of power generating and distribution systems
- Liquefaction
- Tsunami exposure and damage (depending on region)
- Fire and Explosion following earthquakes
- Environmental contamination due to earthquake
- Indirect and consequential losses
- Loss of life and injury

During the second part of this training a suitable number of elements at risks should be inspected in order to ensure efficiency and accuracy in stocktaking and actual risk assessment and vulnerability studies related to stock taking. During this phase the trainees should fill in assessment forms which will be checked and discussed.

It is evident that those who have received such training will be of great value also later in risk optimization projects and in teaching and instructing others.

3. Execution of the Stocktaking

The trained persons would thereafter compile the data and enter it in the maps and forms in order to allow to calculate the total disaster potential for the selected disaster scenariums.

The master plan applying the results of stocktaking to various regions and scenariums should be elaborated under the guidance of the senior expert mentioned earlier.

Thereafter the compiled data will be evaluated by computer for the different scenarios.

4. RECOMMENDATIONS, and REQUIREMENTS

Without proper stocktaking it is impossible to assess the exposure of a region. Stocktaking by adequately qualified and trained people is therefore of primordial importance.

It is seen that the successful execution of the stocktaking requires a sequential procedure and moreover the availability of a managerial and organisational body, of local experts, and of some equipment. Moreover, it is evident that any long-term progress is only possible if experience and know-how can be transferred to local experts.

The number of such experts should not be too small, not only to ensure that the project is completed without undue delay, but to guarantee that those trained and available for monitoring and adjustments required in future are not decimated too much by transfers and other parameters which affect personnel.

With the above in mind the following requirements should be met.

Requirements

4 1. Management and Organizational Problems :

Empower the authority selected to recruit and contract staff and experts needed locally, and establish an office with the basic personnel and equipment. An organogram should be drafted.

4. 2. Maps and Data:

4. 2. 1. Maps of surface geology of adequate quality and information content
4. 2. 2. Detailed maps for entering distribution of buildings
4. 2. 3. Population statistics
4. 2. 4. Maps of utilities, life-lines, and hospitals
4. 2. 5. Maps of chemical plants
4. 2. 6. Map of wind speeds and their probability distribution

4. 3. Local Experts:

4. 3. 1. Civil engineers
4. 3. 2. Mechanical engineers,
4. 3. 3. Electrical engineers
4. 3. 4. Chemical engineer
4. 3. 5. Medical doctor
4. 3. 6. Computer operator (PC-expert)

4. 4. Equipment:

4. 4. 1. Office equipment
4. 4. 2. Vehicle(s) for transporting the experts to the sites of investigation
4. 4. 3. Personal computer of sufficient quality and capacity and suitable soft-ware
4. 4. 4. Equipment and accessories for photo-copying

5. Tentative Time Schedule

The indications given are approximate

5. 1. Preparation of required material as stated above	
5. 2. Preparations of forms and material by the senior consultant	1 week
5. 3. Training course	1 week
5. 4. Stocktaking, e. g. for Yerevan (team abt. 6 experts)	4 weeks
5. 5. Checking and evaluation of data by senior conultant	2 weeks
5. 6. Computational evaluation	4 weeks

6. STOCK-TAKING FORM FOR BUILDINGS

The following form and the instructions appended to it cannot only be used for detailed damage and loss assessments after earthquakes but for stock-taking in the fields of earthquake, flood, and windstorm.

If the form is used for stock-taking, the data entered under items 15 - 24 will represent damage, loss, and casualty estimates.

It has been explained in the text of this section that professional disaster preparedness, planning and management must be based on a quantifying assessment of the hazard. Therefore information on damage or damage potential as alluded to, for instance, in present intensity scales is inadequate for many reasons.

Vulnerability depends on a substantial number of parameters, ranging from subsoil and subsoil-building interaction to factors correlated with details of architecture, design, materials, and workmanship (cf. section III. A. 2. Earthquakes). If stock-taking was, for instance, only carried out considering the criteria defined by intensity scales, the result would in no way represent exposure and in particular not of a modern town.

Moreover, assessing quantities according to the vague indications found in intensity scales will introduce another substantial error potential.

Any responsible party wishing to estimate the exposure which may result from future earthquakes and, for that matter, other perils of nature, should therefore base stock-taking on a detailed quantifying assessment which can be computerized conveniently. Such results of stock-taking are not only mirroring the present situation but can easily be ammended to allow for changes in the composition of the "exposure portfolio".

This form can be used for buildings in factories as well, but it cannot be used for the machinery and equipment because the vulnerability of such items is governed by a large number of different parameters. More details heron are to be found in reference 1. under references, of section III. A. 2.

THE FORM IS TO BE FILLED ACC. SPEC. INSTRUCTIONS

1 EVENT | 1.1. DATE | 1.2. M | 1.3. h | 1.4. EPICENTER

2 LOCATION | 2.1. VIL/TOWN | 2.2. ADDRESS

3 SITE | 3.1. INCLINATION | 3.2. SOIL CLASS. | 3.3.DEPTH TO HARD STR.

3.4. EPIC.DIST. | 3.5.DIR. TO EPIC. | 3.6.DIST.TO FAULT

3.7. DIR. TO FAULT | 3.8. GROUND WATER DEPTH | 3.9. SLIDE | 3.1o.LIQU.

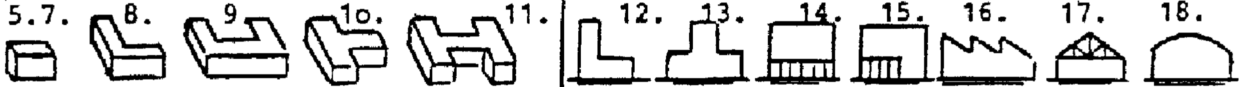
3.11. SETTLEMENT | 3. 12. Orientation of Bldg. (sketch)

4 INTENSITY | 4.1.LOWER LIM. | 4.2.UPPER LIM. | 4.3.AVERAGE

5 BUILDING | 5.1.TYPE | 5.2.BASEMENTS | 5.3.LENGTH | 5.4.WIDTH

5.5.STOREYS | 5.6.HEIGHT

5.7. 8. 9 1o. 11. | 12. 13. 14. 15. 16. 17. 18.



5.2o.SOFT | 5.21.STIFF | 5.22.MIXED | 5.23.AGE | 5.24. Occup.

6 STRUCTURE | 6.1.LOAD SUPP.WALLS | 6.2.SPACE FRAME | 6.3.SP.FR.MOM.RES.

6.4.BRACED SP.FR. | 6.5.BOX SYSTEM | 6.6.MIXTURE

7 MATERIAL STRUCTURE | 7.1.STEEL | 7.2.RC | 7.3.BRICK | 7.4.RUB.MAS. | 7.5.ADO.

8 MATERIAL WALLS | 8.1.PREFAB | 8.2.RC | 8.3.MET. | 8.4.BRICK | 8.5.GLASS

8.6.PANELS

9 FLOORS | 9.1.STEEL | 9.2.RC DIAPHR. | 9.3.RC BEAMS | 9.4.PREFAB | 9.5.WOOD

1o ROOF | 1o.1.RC FLAT | 1o.2.RC SHED | 1o.3.RC SHELL | 1o.4.STEEL | 1o.5.WOOD

11 FOUNDATION | 11.1.SPR.FOOT | 11.2.STRIP | 11.3.RAFT | 11.4.PILE

12 COLUMNS | 12.1. DIM. | 12.2.REINF.

12.3.BINDERS | 12.4.RC

13 BEAMS | 13.1 DIM. | 13.2.REINF.

13.3.BINDERS | 13.4.RC

14 QUALITY | 14.1. MATERIAL | 14.2.WORKMANSHIP | 14.3.RESISTANCE

15 DAMAGE | 15.1. CAUSE | 15.2.DIR.OF DISPLACEMENT

16 STRUCTURAL DAMAGE	16.1. TYPE	16.2.EXTENT(DR)
o1.COLUMNS		
o2.BEAMS		
o3.DIAPHRAGMS		
o4.BRACING		
o5.SHEAR WALLS		
o6.LOAD SUPP.WALLS		
o7.ROOF STRUCT.		
o8.STAIR CASE		

17 NON-STRUCT.DAMAGE	17.1. TYPE	17.2.EXTENT(DR)
o1.WALLS		
o2.PLASTER		
o3.PANELS		
o4.CEILINGS		
o5.FACADING		
o6.ROOF COVER		
o7.WINDOWS		
o8.DOORS		
o9.PLUMBING		
o1o.SANITARY		
o11.LIGHTING		
o12.LIFTS		
o13.AIRCOND.DUCT.		
o14.AIRCOND.M/C		
o15.CONTENTS		
o16.OTHER		

18 INDIRECT DAMAGE | 18.1.FIRE CAUSE | 18.2.FUEL | 18.3.LOSS OF USE

19 DAMAGE RATIOS | 19.1.STRUCTURE | 19.2.NON-STRUCT. | 19.3. MDR

19.4.FIRE | 19.5.CONTENTS | 19.6.LOSS OF USE

2o DAMAGE VALUE | 2o.1.STRUCTURE | 2o.2.NON-STRUCT. | 2o.3. MDR

2o.4.FIRE | 2o.5.CONTENTS | 2o.6.LOSS OF USE

21 MAXIMUM DAMAGE | 21.1. FLOORS | 21.2 SIDE

22 PHOTOGRAPHS NOS. | 24. Casualties k: i:

23 REMARKS (cf. Special Instructions) Sketches: cf. reverse side

QUESTIONNAIRE ITEM	EXPLANATION/EXAMPLE
1.1. DATE	DAY MONTH YEAR 020380
1.2. MAGNITUDE	M x 10 ESTIMATE 62
1.3. FOCAL DEPTH	km
1.4. EPICENTER	SITE EPOCENTER LONG.LAT. 141050280530
2.1. VILLAGE/TOWN	COUNTRY CODE I-3040
2.2. ADDRESS	ROAD NO. (MARK ON MAP)
3.1. INCLINATION OF SURFACE	DEGREES FROM HORIZONTAL
3.2. SOIL CLASSIFICATION	USE NUMBERS UNDER GROUP SYMBOLS

Field Identification Procedures (Excluding particles larger than 3 in and basing fractions on estimated weights)				Group Symbols	Typical Names	Information Required for Describing Soils
Coarse grained soils More than half of material is larger than No 200 sieve size (The No 200 sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than No 7 sieve size (For visual classification, the 1/4 in size may be used as equivalent to the No 7 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW 1	Well graded gravels gravel sand mixtures little or no fines	Give typical name, indicate approximate percentages of sand and gravel, maximum size; angularity surface condition, and hardness of the coarse grains, local or geologic name and other pertinent descriptive information, and symbols in parentheses. For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics. Example: *Silty Sand* gravelly, about 20% hard, angular gravel particles 1/2 in maximum size, rounded and subangular sand grains coarse to fine, about 15% non plastic fines with low dry strength well compacted and moist in place, alluvial sand, (SM)
			Predominately one size or a range of sizes with some intermediate sizes missing	GP 2	Poorly graded gravels, gravel sand mixtures, little or no fines	
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see ML below)	GM 3	Silty gravels, poorly graded gravel sand silt mixtures	
			Plastic fines (for identification procedures, see CL below)	GC 4	Clayey gravels, poorly graded gravel sand-clay mixtures	
	Sands More than half of coarse fraction is smaller than No 7 sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	SW 5	Well graded sands, gravelly sands little or no fines	
			Predominantly one size or a range of sizes with some intermediate sizes missing	SP 6	Poorly graded sands, gravelly sands, little or no fines	
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see ML below)	SM 7	Silty sands, poorly graded sand silt mixtures	
			Plastic fines (for identification procedures see CL below)	SC 8	Clayey sands, poorly graded sand-clay mixtures	

	Identification Procedures on Fraction Smaller than No 40 Sieve Size						
		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)			
Fine grained soils More than half of material is smaller than No 200 sieve size	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	ML 9	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses. For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture, and drainage conditions. Example: *Clayey silt*, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes; firm and dry in place; loess (ML)
		Medium to high	None to very slow	Medium	CL 10	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	OL 11	Organic silts and organic silt-clays of low plasticity	
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH 12	Inorganic silts, micaceous or diatomaceous fine sandy or silty	
		High to very high	None	High	CH 13	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	OH 14	Organic clays of medium to high plasticity	
	Highly Organic Soils	Readily identified color, odor, spongy feel and frequently by fibrous texture			Pt 15	Peat and other highly organic soils	

3.3. DEPTH TP HARD STRATA	METERS
3.4. EPICENTRAL DISTANCE	km
3.5. DIRECTION TO EPICENTER	DEGREES 0 - 360°
3.6. DISTANCE TO FAULT	km SKETCH IF MORE THAN ONE
3.7. DIRECTION TO FAULT	DEGREES 0 - 360°
3.8. GROUND WATER DEPTH	m AT TIME OF EVENT
3.9. SLIDE (IN VICINITY OF BLDG)	YES = 1, NO = 0
3.10. LIQUEFACTION	" "
3.11. SETTLEMENT ON SITE	m
4.1. LOWER LIMIT OF MM ESTIMATE	MMI 1956
4.2. UPPER " " " "	" "
4.3. AVERAGE i.e. MOST PROBABLE	" "

5.1. TYPE OF BUILDING

1. RESIDENTIAL	2. OFFICE
3. SHOP/STORE	4. WAREHOUSE
5. INDUSTRIAL	6. CINEMA/THEATRE
7. CHURCH	8. PARKING

5.2. BASEMENTS	NUMBER
5.3. LENGTH	m MAIN DIMENSION
5.4. WIDTH	m MAIN DIMENSION
5.5. STOREYS	NUMBER
5.6. HEIGHT	m SHEDS OR IF STOR.NO MISSLEADG.
5.7. - 11. FLOOR PLAN	MARK NEAREST
5.12. - 18. ELEVATION	MARK, IF NECESS. 2 FOR TWO ELEV.
5.20. - 22. SOFT, STIFF, MIXED	MARK, DETAILS UNDER REMARKS
5.23. ESTIMATED AGE	YEARS
6.1. - 6. STRUCTURAL CRITERIA	MARK ACCORDINGLY, STATE % MIX
7 MATERIAL STRUCTURAL PARTS	MARK ACCORDINGLY
8 MATERIAL WALLS	MARK ACCORDINGLY
9 MATERIAL STRUCT. PARTS FLOORS	MARK ACCORDINGLY
10 MATERIAL STRUCTURAL PARTS ROOF	MARK ACCORDINGLY
11 TYPE OF FOUNDATION	MARK ACCORDINGLY
12.1. DIMENSIONS COLUMNS	STATE CONSECUTIVELY AS UNDER

WIDTH (cm), DEPTH (cm), DIAMETER LONGITUDINAL BARS (cm), NUMBER LONG. BARS

12.2. REINFORCEMENT	ORDINARY = 1 HIGH TENSILE = 2 PRESTRESSED/POSTTENSIONED = 3

12.3. BINDERS

DISTANCE (cm), DIAMETER (mm), TYPE: ORDINARY SQUARE = 1, SQUARE WITH REINFORCEMENT = 2, SPIRAL = 3.

12.4. ESTIMATED CONCRETE QUALITY

13 BEAMS	LIKE COLUMNS (DEPTH = HEIGHT)
14.1 QUALITY MATERIAL	1 = ABOVE AVERAGE, 2 = AVERAGE, 3 = BELOW AVERAGE, 3 = BAD
14.2. QUALITY WORKMANSHIP	LIKE MATERIAL
14.3. RESISTANCE	ESTIMATED RESISTANCE IN % OF g

15.1. DAMAGE CAUSE

1. LIQUEFACTION	2. SLIDE
3. SETTLEMENT	4. FOUNDATION FAILURE
5. OVERTURNING	6. SHEAR FAILURE
7. COMPRESSIONAL OVERLOADING	8. EXCESSIVE BENDING/DISPLACEMENT
9. TORSIONAL OVERLOADING	10. FAILURE OF INTERCONNECTIONS
11. HAMMERING	12. BAD DESIGN
13. BAD MATERIAL	14. BAD WORKMANSHIP

15.2. DIRECTION OF DISPLACEMENT	PREDOMINANT DIRECTION OF DISPLACEMENT IN DEGREES 0 - 360°

16.1. DAMAGE TYPE (STRUCTURAL)

1. COLLAPSE	2. PARTIAL COLLAPSE
3. AXIAL CRACKING	4. BASKETING
5. DRIFT	6. DIAGONAL CRACKING
7. SPALLED CONCRETE	8. FAILURE AT & OF JOINTS/CONNECT.
9. LIFT-OFF	10. BUCKLED STEEL MEMBERS
11. FAILURE OF WELDS	

16.2. EXTENT OF DAMAGE (DR) — % OF ALL SIMILAR ITEMS IN BLDG.

17.1. DAMAGE TYPE (NON-STRUCTURAL)

1. OVERTURNING/FALLING	2. COLLAPSE (TOTAL)
3. COLLAPSE (PARTIAL)	4. AXIAL CRACKING
5. DIAGONAL CRACKING	6. BUCKLING
7. DISLODGEMENT	8. DISENGAGEMENT/BOND-/CONNECTION FAILURE
9. RUPTURE	

17.2. EXTENT OF DAMAGE (DR) — % OF ALL SIMILAR ITEMS IN BLDG.

18.1. FIRE DAMAGE CAUSE

1. SHORT CIRCUIT	2. OPEN FIRES
3. HAMMERING	4. STATIC ELECTRICITY
5. FIRE IN VICINITY	

18.2. FUEL INVOLVED AT START

1. FURNITURE	2. OFFICE EQUIPMENT
3. GAS	4. LIQUID FUELS
5. SOLID FUELS	

18.3.	LOSS OF USE	YES = 1, NO = 0
19.1.	DAMAGE RATIO OF STRUCTURE	% OF ALL STRUCTURAL PARTS
19.2.	DAMAGE RATIO OF NON-STRUCTURAL PARTS	% OF NON-STRUCTURAL ITEMS OF BLDG.
19.3.	DAMAGE RATIO FIRE	ADDTL. FIRE LOSS IN % OF BLDG. VALUE
19.4.	DAMAGE RATIO CONTENTS	% OF CONTENTS VALUE
19.5.	LOSS OF USE DAMAGE RATE	DAYS OF OUTAGE
20	DAMAGE VALUES	STATE IN US DOLLARS
21.1.	FLOORS WITH MAX. DAMAGE	STATE NO. IN DESCENDING ORDER
21.2.	SIDE OF MAX. DAMAGE	IN DEGREES o - 360°
22	PHOTOGRAPHS NOS	STATE CAMERA COUNTERS NOS
23	REMARKS	STATE EARLIER CODE NO BEFORE REMARK DETAILS AND SKETCHES IF OF INTEREST ON REVERSE SIDE OF SHEET.

ADDITIONAL INSTRUCTIONS

3. 12. Show orientation of Building in Sketch

5. 24. Indicate number of occupants

24. State Casualties, i. e. k: = killed, i: = injured

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