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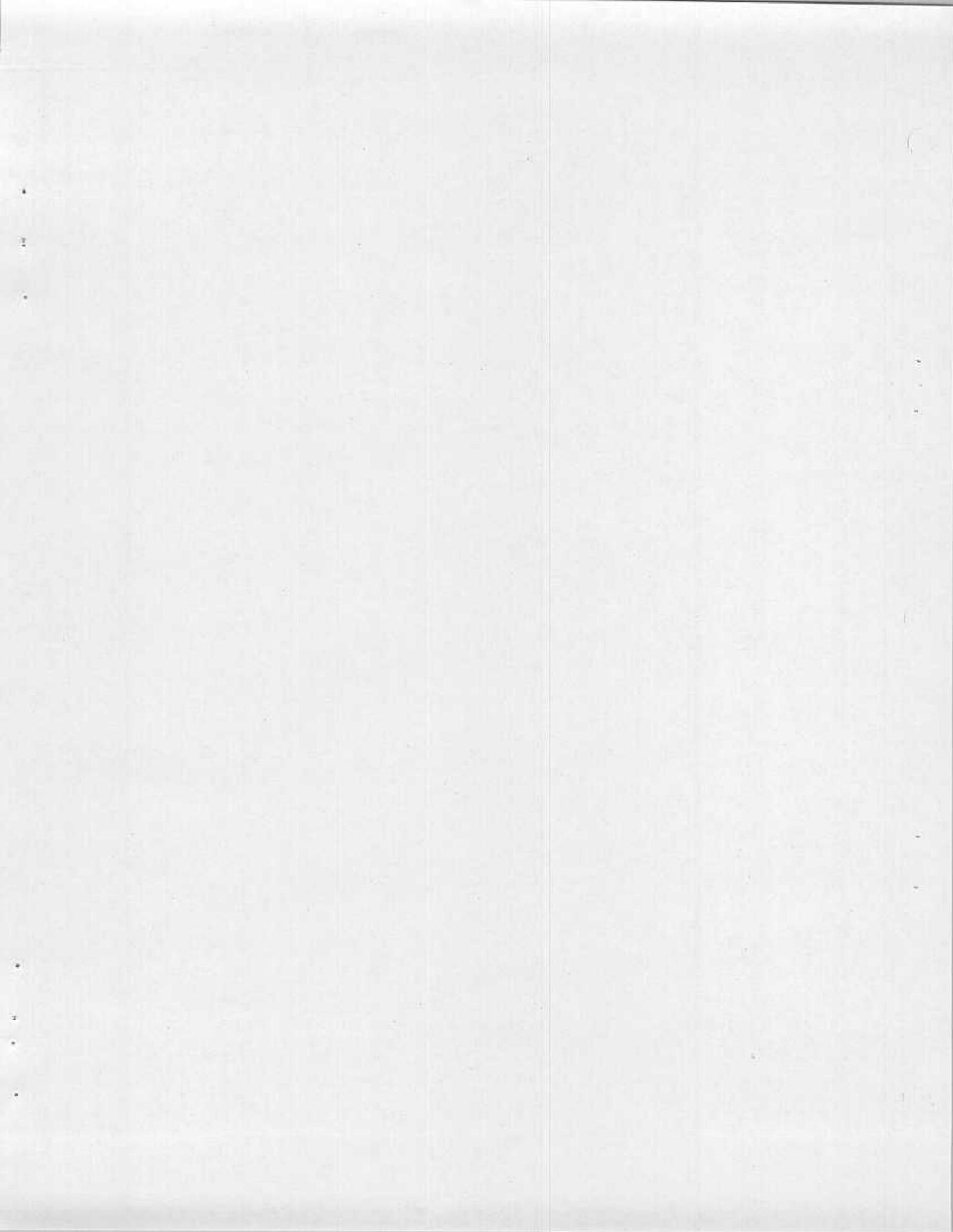
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APPENDIX A

Opening Speech by H. E. Nurettin Ok at the  
Fifth European Conference on Earthquake Engineering  
September 22, 1975



OPENING SPEECH BY H. E. NURETTIN OK  
AT THE FIFTH EUROPEAN CONFERENCE  
ON EARTHQUAKE ENGINEERING

Mr. Chairman, Distinguished delegates to the Fifth European Conference on Earthquake Engineering.

On behalf of the Turkish Government I take deep pleasure in welcoming you to Turkey, where you will be attending this Conference which is held every four years.

The entire Turkish Nation was saddened fifteen days ago when an earthquake took place in the Diarbakir region. It grieves me to state that more than two thousand of our countrymen lost their lives in this catastrophe, and approximately three thousand dwellings were rendered uninhabitable. This disaster has caused great grief for our Nation, a grief which is undoubtedly shared by all people of the world.

Located on a major earthquake belt, this country has for centuries been forced to suffer the bitter consequences of this disaster, and much loss of life and property. This in turn has required that we deal with Engineering Seismology and Earthquake Engineering extensively. Although at present we have many more qualified scientists and experts in seismology and earthquake engineering than we did until quite recently, we are still in a position where we need to benefit from modern research and recent experience gained in countries that are advanced in these fields. Viewed in this context, I believe meetings such as this which permit extensive exchange of information and experience are invaluable to countries which have much to learn in the earthquake field. This has been the basis for my statement expressing the pleasure of the Turkish Government.

I would like to take this opportunity to summarize the "Pre-earthquake" activities conducted by the Ministry for which I am responsible. The primary duty of the Ministry of Reconstruction and Resettlement of the Govern-

ment of Turkey is to make the issue of earthquake-preventive measures understood and popularized by the entire society. Today, particularly in rural areas of Turkey a great percentage of dwelling units consists of houses constructed either by their owners themselves or by local masons. While the government tries to ensure that those units possess certain technical qualifications in conformity with local climatic conditions and available construction materials, we also attach great importance to the education of the people and of the masons in the subject of earthquake resistant construction. Some foreign experts to whom we were able to give details of this project have termed it the "Turkish Experiment" and evaluated it as an exemplary work from which developing nations likely to experience earthquakes could benefit. The initial regional pilot which we undertook in Erzincan, the site of the truly great earthquake disaster of 1939, has been eagerly received by the people and the local builders, and has yielded strong indications which will be of aid in further project work. Also within the same project 500,000 large size color posters containing suggestions and technical details to be observed in the construction units conforming to local conditions have been printed and distributed to all villages, schools and other institutions. Provincial governing bodies have been entrusted with the task of overseeing that all rural construction be done in accordance with these suggestions. Supported by television and radio broadcasts, various handbooks, fully equipped educational vans, and other activities local and regional courses and meetings, our educational efforts will continually grow in coverage especially in earthquake prone areas. We hope that this will allow our people to reach a total realization of earthquakes and earthquake resistant construction. Members of the technical staff of the Earthquake Research Institute will gladly provide additional information on the Project to those guests who request this.

Another study which the Earthquake Research Institute has undertaken is the preparation of microzonation maps particularly for potential settlement areas and industrial regions and to provide the necessary data to planners and executors. One subject to which we attach great importance is the establishment in the near future of a strong-motion instrument and seismograph network which in time should provide the required instrumental

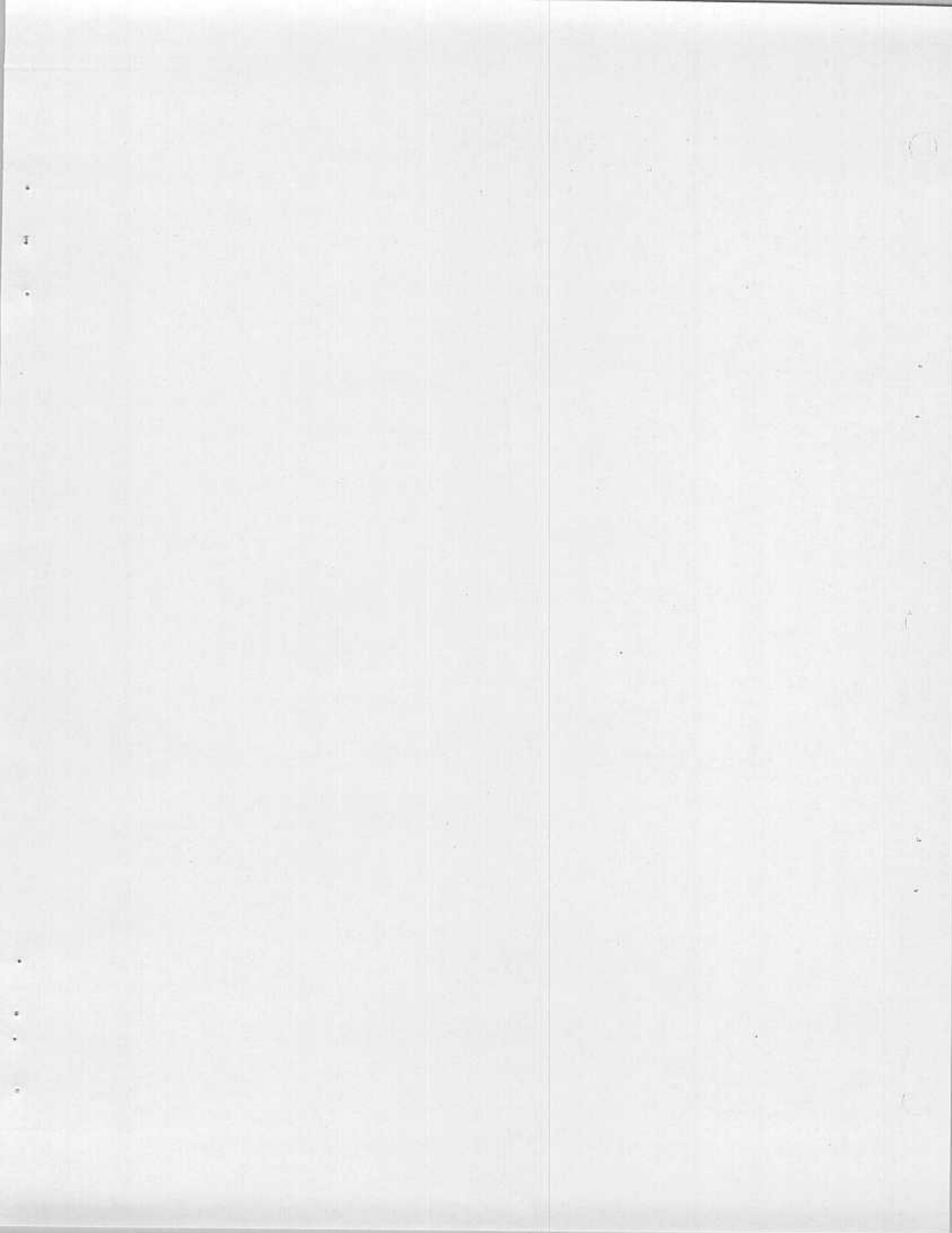
records. After the completion of this work which at present is being carried out in two separate projects, we expect to improve both the earthquake zoning map of Turkey and the Earthquake Code.

Distinguished Delegates, guests,

As a minister who has followed the preparatory work closely, I sincerely believe that this Conference, which the Organizing Committee did its utmost to organize in every detail, will be conducted and completed with great success as others have been before it. I hope that you will take this opportunity to get acquainted with some touristic and historical attractions of our country. The Turkish people will be pleased to show you their traditional hospitality.

In conclusion I wish to express my appreciation and gratitude to the Organizing Committee and to all those who have contributed to the realization of this Conference, to our universities, men of science and my colleagues. I wish you all a very successful conference.

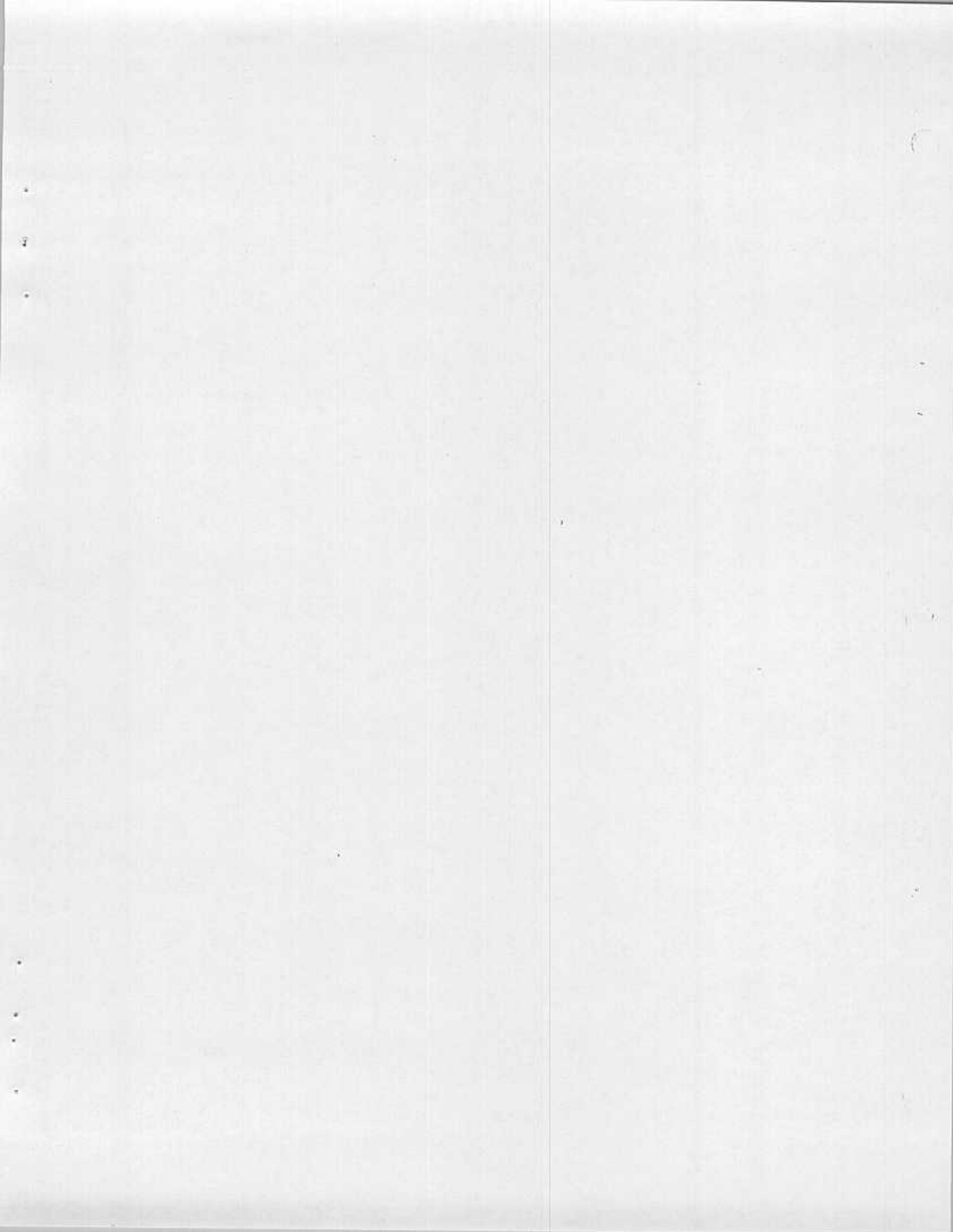
Thank you.



APPENDIX B

"Public Education Project on the Subject of  
Earthquakes and Earthquake Resistant Construction,"  
by the Republic of Turkey Ministry of Reconstruction and Resettlement,  
Earthquake Research Institute,  
Ankara, 1973





REPUBLIC OF TURKEY  
MINISTRY OF RECONSTRUCTION  
AND RESETTLEMENT

PUBLIC EDUCATION PROJECT ON THE SUBJECT  
OF EARTHQUAKES AND EARTHQUAKE RESISTANT CONSTRUCTION

EARTHQUAKE RESEARCH INSTITUTE

ANKARA 1973

PROJECT NAME	Public education project on the subject of earthquakes and earthquake resistant construction.
AUTHORITY RESPONSIBLE FOR THE EXECUTION OF THE PROJECT AND LEGISLATIVE AUTHORIZATION	<p>Earthquake Research Institute, Ministry of Reconstruction and Resettlement.</p> <p>Article 2, paragraph E of Law No. 7116 and Article 5 of Law No. 7269/1051 gives the duty of "Investigation and implementation of the necessary measures for the protection of the lives of the citizens and the national wealth" to the Ministry of Reconstruction and Resettlement (in turn to Earthquake Research Institute).</p>
2. AIM OF THE PROJECT	Providing the necessary information concerning the methods of earthquake resistant construction of houses and site selection that best fit the local conditions, the qualified construction workers and foremen that aid the people, and particularly the people living in earthquake regions. Reducing the loss of life and material as much as possible within the existing capacity.
3. PROJECT DURATION	A large-scale continued education is basic for the achievement of the aims of the project. In spite of this, with the assumption that at the end of the basic duration period the project will be considered not as a special project but will gain its natural continuity, it was considered that the project will be realized between 1974 and 1977.
4. PROJECT DESCRIPTION	Ninety-one percent of the country is located in earthquake regions, and 95 percent of the population lives in these regions. A large part of the people while they are constructing their own homes have no access to technical

information help. Most of the construction laborers and foremen that can help the people in the construction of houses, barns, and storage places using primitive construction material have practically no information on earthquakes and earthquake resistant construction practices.

On the selection of suitable sites for house construction, the geological characteristics of the land are never taken into consideration. "The Regulations Concerning the Construction of Structures within the Disaster Regions," prepared by the Ministry of Reconstruction and Resettlement, has practically no influence on the people living in villages and small towns that build their own homes. For this reason, the aim that was intended to be achieved by this regulation can only be achieved by a large-scale education effort.

The failure of adobe houses which can resist 5 to 6 and even 7 intensity earthquakes with slight cracks by the application of minimum technical measures, under low intensity earthquakes, results in loss of life and material damage thus the percentage of damage increases greatly.

Comparing the percentage of losses in advanced countries with Turkey, it will be found that while the loss ratio is very low in those countries, every measure is taken to make it even lower; keeping these facts in mind, it will become apparent that besides the measures taken by the state, the importance of the full-scale participation of the public in this struggle is very important.

It was considered that the public education project on earthquakes and earthquake resistant construction should include the following media:

- a. Radio and television programs
- b. Handbooks
- c. Wall posters
- d. Conferences, debates, movie shows, informal discussions
- e. Education of instructors, foremen, and laborers
- f. Cooperation with the Ministry of National Education for the inclusion of necessary topics into the school curriculums.

a. Radio and Television Programs.

One of the things that should be considered is the use of radio and television, which are both public communications media, in the education of the public on earthquakes like they are used in other education programs. Particularly television has a great influence since it covers both hearing and vision.

Considering the efforts of TRT (Turkish Radio and Television Network) towards providing all over the country television broadcasting as quickly as possible and by the production of transistorized television receivers to receive television broadcasts even in the most remote villages, preparations should be started for the utilization of this capacity as quickly as possible. Preparation of interesting and useful television programs for the implementation of earthquake resistant construction principles in cooperation with TRT and occasional inclusion of radio programs dealing with the earthquakes and earthquake resistant construction topics into the educational radio programs of Radio Turkey specially prepared for

the villages and listeners in villages constitutes a major part of this project. Due to their preparation as "Package Program," these programs can be used by the existing and future broadcasting stations at any time.

b. Handbooks

As mentioned earlier, the presentation of technical explanations given in the "Regulations Concerning the Construction of Structures within the Disaster Regions," published by the Ministry of Reconstruction and Resettlement, in the form that can be of more use to the villagers, village construction laborers, and foremen, that prepares his own adobe mortar mix, pours it into forms, lays his own wall, and builds his own roof, constitutes the second portion of the education project. The handbook envisaged within the project framework is shown in Table 1.

TABLE 1

<u>Subject of the Handbook</u>	<u>Number To Be Printed</u>
Earthquakes and earthquake resistant construction information for the people who build their own homes	200,000
Earthquake resistant building construction methods for the construction foremen	50,000

Handbooks will be approximately 60 to 80 pages and, if possible, will have plastic covers.

c. Wall Posters

Turkish people have an inborn inclination towards pictures. Almost in all the village coffee-houses and guest houses there will be pictures of famous Turkish men posted on the wall along with the educational posters

covering one topic or another. For this reason wall posters to be prepared covering the topic earthquake resistant construction in color, schematically showing details of construction with simple explanations, will undoubtedly have an important place within this project.

It was considered that wall posters that people could study easily and that would be continuously in front of their eyes would provide great benefits on the topic of earthquakes and earthquake resistant construction. These posters, as in all the other aspects of the project, will be free from all kinds of unnecessary details and be prepared in a form suitable to the project aims with a printing and a picture technique that appeals to the eye.

The kind of posters to be printed are given in Table 2

TABLE 2

Poster Name	Number To Be Printed
Site selection	200,000
How to construct 1	200,000
How to construct 2	200,000
How to construct 3	200,000
What to do in an earthquake	200,000

d. Conferences, Debates, Movie Shows, Informal Discussions.

In the first degree earthquake regions, particularly starting from the residential areas showing poor construction techniques, for the education of the people as stated in the project aim, the use of the above educational means and ways was accepted to be one the main points to be taken into consideration. In this field the use of the provincial offices of

the Ministry of Reconstruction and Resettlement and municipalities that fall within the project region will be made. With the help of the teaching personnel selected from these organizations and educated to serve the purpose, the capacity for the speedy application and the enlargement of the project will be available. It is anticipated that particularly the construction foremen within the region that help the people for their home construction will be educated by these teaching personnel and teaching organizations on the earthquake resistant construction principles. When required, it is anticipated that mobile teaching teams will be useful for education of the villagers and their foremen living in distant villages and to provide them with the necessary information. These teams will be composed of one vehicle driver, one or two instructors, and one field car carrying all the teaching equipment. These cars will have a power generator, 16mm movie projector, slide projector, and other educational aids. Vehicle drivers will also be trained for the use of this equipment.

The number of such teams that will be established within the project duration is as shown in Table 3.

TABLE 3

<u>Year</u>	<u>Number of Teams To Be Formed</u>
	2
	3
	3
	3
<b>TOTAL</b>	<b>12</b>



e. Education of Instructors, Foremen, and Laborers

Even though this constitutes a separate section, since the methods and techniques that shall be applied for their education is the same, the particulars related to their duties are explained in Section (d).

The education of the foremen and laborers will mostly be carried out by provincial branch offices of the ministry and the municipalities. The duty of each one will be the training of the personnel that are going to carry out the education. Depending on the local conditions, educational programs for the foremen will be arranged at provincial or county seat levels. In this purpose mobile teams will also be utilized.

The number of instructors and the foremen to be educated within the five-year planned period is shown in Table 4.

TABLE 4

<u>Year</u>	<u>Instructors</u>	<u>Foremen</u>
		500
		1500
		2500
		3500

It is assumed that personnel to be utilized as instructors will train on the average 10 foremen per year besides their regular duties.

f. Cooperation with the Ministry of National Education for the Inclusion of Necessary Topics into the School Curriculums.

It was considered that by the cooperation of the Ministry of Reconstruction and Resettlement and the Ministry of National Education, education and training programs towards implementation at all levels could be developed into more useful forms. Particularly in the preparation of 8-year primary school education programs, cooperation regarding the earthquakes and earthquake resistant construction topics is required. In the primary education section of the National Educational Reform program, in the case of students terminating their education, supplying them with useful capacities is anticipated. In such cases, providing these students with basic information and experience on earthquakes and earthquake resistant construction methods will be very useful within the framework of the project.

5 PROJECT

COST (Note:

15 TL  $\approx$  \$1.00)

a. Radio and Television Programs.

Without the establishment of principles of cooperation with TRT, it is impossible to determine whether any expense is required from the Ministry and if so what will be the amount expected to be spent by the Ministry. For this reason, assuming some amount of expense by the Ministry, 50,000 TL has been set aside under this section.

b. Handbooks

It is assumed that 300,000 TL will be spent on the 200,000 handbooks printed for the people that build their own houses, and 100,000 TL will be spent for the 50,000 handbooks to be printed for the foremen.

c. Wall Posters.

It is assumed that each one will cost approximately 1 TL, so they will cost 1,000,000 TL. They will have 70 x 100 cm dimensions and be printed in four colors. Being of finer quality paper than handbooks, their cost is higher. In fact it has been assumed that paper for the books and the posters will be directly obtained from SEKA (State Paper Company), and the costs are estimated accordingly.

d. Training Vehicles

It is assumed that each training vehicle will cost 150,000 TL, including the teaching aids and other audiovisual equipment.

e. Instructors

For the training of instructors, 25,000 TL/year will be set aside for covering the general expenses.

It is assumed that foremen will receive 10 days of training and during this period they will receive 15 TL/day as a training stipend. It is felt that such a small reward will encourage regular attendance of the course.

f. Joint Program Works with the Ministry of National Education.

No fund allocation for this project at this stage

Note: Personnel salaries, travel expenses, and stipends were not considered within the project costs.

The total project cost with its annual distribution is shown in Table 5.

TABLE 5

<u>Years</u>	<u>TV-Radio</u>	<u>Handbooks</u>	<u>Posters</u>	<u>Training Vehicles</u>	<u>Training</u>	<u>Annual Total</u>
				150,000		,225,000
		200,000		300,000		600,000
		100,000		450,000		800,000
				450,000		850,000
				450,000		,000,000
<u>TOTAL (TL)</u>	<u>50,000</u>	<u>300,000</u>	<u>1,000,000</u>	<u>1,800,000</u>	<u>1,325,000</u>	<u>4,475,000</u>



APPENDIX C  
EARTHQUAKE RESISTANT REGULATIONS  
A WORLD LIST  
1973

TURKEY

EARTHQUAKE BUILDING CODE REGULATIONS

January 16, 1968

\* \* \* \* \*

THE CRITERION TO BE TAKEN INTO CONSIDERATION  
FOR THE EARTHQUAKE EFFECTS  
IN THE DESIGN OF DAMS

\* \* \* \* \*

THE PROCEDURES OF THE GENERAL DIRECTORATE OF HIGHWAYS  
FOR THE PROJECTS IN THE REGIONS OF EARTHQUAKE

\* \* \* \* \*

THE PROCEDURES OF THE DEPARTMENT  
OF RAILROAD AND HARBOR CONSTRUCTION  
FOR THE PROJECTS IN THE EARTHQUAKE REGIONS

*Compiled by the*

INTERNATIONAL ASSOCIATION  
FOR EARTHQUAKE ENGINEERING

April 1973

*Central Office*

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# TURKEY

## REGULATIONS FOR STRUCTURES TO BE BUILT IN EARTHQUAKE RISK ZONES

### Scope of the Regulations:

- Section 1: Government or private buildings to be constructed, altered, expanded or to undergo major repair work in earthquake risk zones shall be subject to the provisions of this code as indicated in Section 3 of Act 7269.
- Section 2: Requirements for structures like dams, bridges, mosques, minarets, tall chimneys, transmission towers, etc., not covered by this code, shall be determined by the Ministries supervising the construction, and the pertinent projects shall be designed accordingly.

## CHAPTER 5

### General Requirements for Materials and Labour:

- Section 7: The standards of materials and labour in buildings to be constructed in earthquake risk zones shall conform to:
- "General Building Specifications", Ministry of Public Works.
  - "Specifications for Reinforced Concrete", Turkish Association of Bridge and Structural Engineering.
  - "Specifications for Timber Structures".

## CHAPTER 6

### Seismic Design Principles Reinforced Concrete Structures:

- Section 8: Structures utilising vertical and horizontal reinforced concrete elements in order to transfer dead and live loads to the foundation shall hereafter be referred to as "Reinforced Concrete Frame Structures".
- Structural layouts shall be as simple as possible. Square or rectangular plan dimensions shall be preferred. In Reinforced Concrete frame structures, the centre of rigidity of lateral load carrying columns and shear walls shall coincide as much as possible with the centre of mass of the structure.

### 8.1. Construction Joints

- Structural joints designed for the effects of temperature changes, shrinkage, set backs and soil conditions shall have a minimum width of 3 cm. up to a height of 6.00 m.
- In taller structures, the gap at the joints shall be increased by 1 cm. for every 3 metres of height.
- Structural joints may be omitted in foundations, except those designed for set backs and/or poor soil conditions.

### 8.2. Restrictions on Heights of Structures

There is no specific restriction on the height of a reinforced concrete frame structure, provided that it is designed in accordance with the provisions of section 8 of this code. Reinforced concrete frame structures with heights from soil base exceeding 44.00 m., shall be designed by means of an appropriate dynamic analysis considering the character and magnitude of earthquakes to be resisted, soil conditions and structural characteristics. Same provisions shall apply to the new and/or existing frames of the repaired structures.

### 8.3. Preparation of Foundation Base and Foundations

- All foundations shall be constructed in such a way that cracking will be prevented for any beam or column due to differential settlement. Further,
- Soil studies shall be performed by means of an appropriate method which accounts for the soil conditions, structural properties of the building and dynamic characteristics of the earthquake.
  - Foundation depths shall be determined according to building and soil characteristics.
  - In poor soil, the methods of improvement of the soil conditions shall be investigated.
  - Under each foundation there shall be a concrete layer with a minimum thickness of 10 cm. and a cement content of 150 kg.
- ### 8.4. Foundation Ties
- Ties shall be provided in both directions for foundations of buildings supported on piles and on individual footings.

The tie beams shall frame to the upper level of the pile-cap or footing. In continuous footings, foundation ties shall be provided, so as to tie each column on the foundation to the nearest adjacent columns on similar continuous footings. These ties shall frame to the uppermost level of the foundation member and shall have a tensile capacity of not less than 10% of the load carried by the column below which the member frames into the foundation.

In first degree earthquake zones, for soils other than bedrock, tie beams shall have a minimum cross sectional area of  $900 \text{ cm}^2$  with the least dimension not less than 20 cms and shall have a minimum of 4  $\phi$  16 bars as longitudinal reinforcement. In second and third degree earthquake zones, as well as in bedrock bases of first degree zones such tie beams shall have a minimum cross sectional area of  $700 \text{ cm}^2$  with the least dimension not less than 20 cm and shall have a minimum of 4  $\phi$  14 bars as longitudinal reinforcement. Stirrups for tie beams shall consist of  $\phi$  6 bars and maximum stirrup spacing shall be less than the largest dimension of the tie beam.

b) Reinforced concrete slabs may be used in lieu of tie beams. Such slabs shall have a thickness not less than 15 cms, nor less than 1/50 of their centre to centre span. Minimum reinforcement for such slabs shall be not less than  $2.50 \text{ cm}^2$  per meter on each face and in both directions. The elevation of slab-bottom with respect to the foundation top shall be not less than 30 cms for at least 80% of the foundations. Tie-slabs used in this manner shall have sufficient rigidity in all horizontal directions and special attention shall be given to the details of reinforcement at regions where the slab frames into the column in order to distribute the lateral forces properly within the slab.

#### 8.5. Columns

a) Columns shall be placed concentrically on each other along the height of the structure. If possible, all columns should fall onto a straight line in both directions.

b) Where beams frame into columns, the spacing of stirrups and column ties shall be half the spacing at mid-regions of these members, within a distance not less than the effective depth of the deepest beam framing into the joint. Column ties shall be continued within the storey beams.

c) The least dimension of columns shall be not less than 24 cm, nor less than 0.05 times the storey height.

d) Sufficient dowels with the specified bond length shall be provided in columns for tie and bond beams.

#### 8.6. Shear Walls

a) Shear walls shall have a thickness of not less than 20 cm nor less than 0.04 times the storey height. The reinforcement percentage provided in such walls shall be not less than 0.0025 on each face and in both lateral and vertical directions. The maximum spacing of reinforcing bars shall be not more than the thickness of the shear wall.

b) For each opening not exceeding 15% of the shear wall area in each storey, special reinforcement of at least 2  $\phi$  16 bars shall be provided on all sides. For larger openings the reinforcement shall be calculated by a pertinent form of analysis. The area of the bars provided in this manner shall not be less than the area of the bars cut-off to allow for the opening. Special skew reinforcement of not less than 2  $\phi$  16 bars making a degree of  $45^\circ$  with the horizontal shall be provided at each corner of the opening. Such bars shall be extended beyond the opening by a length not less than the required anchorage length.

c) Shear walls shall be placed concentrically along the height of the structure.

#### 8.7. Slabs

a) Reinforced concrete slabs shall have a minimum thickness of 10 cm, except for slabs carrying only roof loads which shall have a minimum thickness of 8 cm.

b) The minimum thickness of cantilever slabs shall not be less than 1/12 of the unsupported length.



c) Special reinforcement of at least 2  $\emptyset$  12 bars shall be provided around openings in simply supported slabs and such reinforcement shall not be less than the amount of reinforcement cut-off for the opening.

d) Rib-slab systems shall not be constructed in 1st and 2nd degree earthquake zones.

#### 8.8. Beams

a) Reinforced concrete beams shall have minimum dimensions of 15 x 30 cms, and the effective depth shall not be less than 3 times the thickness of the adjoining slab.

b) The percentage of longitudinal reinforcement in beams shall not be less than 0.0025. Sufficient transverse reinforcement shall also be provided.

c) The use of haunches is recommended in beam-column connections.

#### 8.9. Filler-Walls

a) Walls shall be as light and as thin as possible.

b) The clear height of walls shall not exceed 3.00 m. In the case of higher walls, bond beams shall be provided at certain intervals.

c) Isolated walls or partition-walls not connected to other walls shall be made of at least 1/2 brick 11 cm or 10 cm thick concrete blocks. In such walls cement mortar containing 250 kg cement per cubic meter of mortar shall be used.

d) On slabs, where the wall does not bear directly upon a supporting beam, the maximum thickness shall be 1/2 brick (11 cm) or 10 cm concrete block.

### Masonry Structures:

Section 9: Structures that have no load carrying frames but have bearing walls made of rubble, cut stone, brick, concrete blocks or acceptable patented filler blocks, having masonry stairs and reinforced concrete slabs or any other floor slab system having the lateral rigidity provided by a reinforced concrete slab shall hereafter be referred to as "Masonry Structures".

Allowable heights for masonry structures are limited to three storeys in first degree earthquake zones, four storeys in second and third degree earthquake zones, excluding basements,

provided a sufficiently rigorous statical analysis is carried out and due care is exercised as regards earthquake resistant construction principles.

Chimney stacks, ornamental facade stuccos, cantilever elements and balconies, connected to masonry structures shall be designed for three times the seismic coefficient  $C$ . The value of  $(\gamma)$  shall be taken as equal to 1 (See section 16.a.2).

#### 9.1. Foundations

All foundations shall be constructed in a way as to prevent differential settlements leading to cracks in walls or columns. In extremely poor soil conditions or in areas where the soil profile exhibits variations, the type, dimension and method of construction of foundations shall be determined by the building authorities. For all foundations carrying exterior walls, bearing walls, partition walls and columns:

I. In third degree earthquake zones, in soils with medium and good characteristics:

i) The minimum width of foundations shall not be less than  $(t + 15 + 15)$  cms where  $t$  = width of wall or column and 15 cms is the width of the clearance on each face of the wall or column, nor less than 45 cms.

ii) The minimum thickness of footings shall not be less than 20 cms.

iii) Foundations shall be made to bear upon solid undisturbed ground in appropriate pits or trenches which shall have minimum depth of 45 cms. Such pit or trench bottoms shall be levelled. In sloping grounds foundations can be constructed in steps. The maximum height of each step shall not exceed 30 cm nor shall overlaps be less than 20 cms.

II. In third degree earthquake zones, in poor soils or in second degree earthquake zones, in soil with medium and good characteristics:

i) Foundation width, thickness, depth and steps shall conform to the requirements of Section 9.1/I(i), (ii) and (iii).

ii) In stepped foundations bond beams and their reinforcement shall be continued into each step.

iii) Footings shall be made of concrete and shall contain at least 2  $\phi$  12 longitudinal reinforcing bars placed about 5 cms from the side and base of the foundation.

iv) For each column foundation appropriate reinforced concrete tie beams shall be provided. Such beams shall tie the column foundation to the nearest adjacent column or wall-foundations. The strength of column foundation shall not be less than as required in (i), (ii) or (iii).

It is not required that these tie beams be at the level of foundations, however they shall be placed below the natural ground level around the building. In all cases, the reinforcing bars of such tie beams shall be anchored into columns or foundations.

III. In second degree earthquake zones, on poor grounds; in first degree earthquake zones, in soils with medium and good characteristics:

i) Foundation width, thickness and depth shall conform to the requirements of section 9, 1/II, (i) and (ii). However, stepped foundations may only be utilized upon the written permission of the Building Official. The Building Official may stipulate certain conditions as regards this matter.

ii) Footings shall be made of concrete and shall contain at least 4  $\phi$  12 reinforcing bars. Such reinforcement shall not have a horizontal spacing of less than 30 cms, a vertical spacing of less than 10 cms nor shall the clear spacing be more than 45 cms. Longitudinal reinforcement shall be tightly secured to vertical stirrup bars.

iii) Section 9 1/II, subsection (iv) applies.

In all earthquake zones:

Foundations supporting non-bearing one-storey walls;

i) Shall have a minimum width not less than 30 cms nor a minimum thickness less than 15 cms.

ii) Shall be made to bear upon compacted ground.

iii) Shall be made of concrete and shall contain at least 2  $\phi$  12 bars placed 5 cm away from the sides.

V. The cement content for concrete shall be as follows:

250 kg/m<sup>3</sup> for reinforced concrete

200 kg/m<sup>3</sup> for unreinforced concrete

#### 9.2. Walls

a) Materials: Concrete blocks, rubble, cut-stone, bricks, concrete blocks with or without cavities and patented special filler blocks shall be used as wall building materials.

Foundation walls and basement exterior walls shall be built of concrete or cut-stone, basement interior walls of concrete, brick or solid concrete blocks, and storey bearing walls of brick or solid concrete blocks.

In concrete walls the minimum cement content shall be 200 kg/m<sup>3</sup>. For stone walls a cement mortar of at least 200 kg/m<sup>3</sup> cement content or a lime mortar reinforced with cement of at least 150 kg/m<sup>3</sup>. For brick and concrete block walls the mortar grade shall be determined according to the magnitude and nature of the loads carried by the wall.

b) Number of Storeys and Wall Thicknesses: Minimum wall thickness in cm for 1st degree earthquake zones.

No. of Storeys Including Basement	Stone or Concrete	Brick	Solid Concrete Blocks
4	Basement	60	35
	Ground	30	35
	First	-	23
	Second	-	23
	Basement	60	35
	Ground	50	23
	First	-	23
	Basement	50	35
	Ground	50	23
1	Ground	50	23

Minimum Wall Thickness in cm for 2nd and 3rd Degree Earthquake Zones

No. of Storeys Including Basement	Stone or Concrete	Brick	Solid Concrete Blocks
5	Basement	60	47
	Ground	50	35
	First	-	35
	Second	-	23
	Third	-	23
4	Basement	60	35
	Ground	50	35
	First	-	23
	Second	-	23
3	Basement	60	35
	Ground	50	23
	Forst	-	23
2	Basement	50	35
	Ground	50	23
1	Ground	50	23

Building foundation walls shall be at least 10 cm thicker than basement walls.

Storey height shall be taken as top to top distance between floors. The ratio of storey height to wall thickness shall be less than 8 for stone walls and less than 15 for brick and concrete block walls.

c) Wall Openings: The ratio of the total area of openings on any face of a building to that face area shall not exceed 0.4 in 1st and 2nd degree earthquake zones, and 0.5 in 3rd degree earthquake zones. The maximum opening width in interior and exterior walls shall be 3.00 m.

In first degree earthquake zones, the minimum width of solid wall between the end corner on the building face and the nearest window or door opening shall be not less than 1.50 m. In the cases where the building height is less than 7.50 m or the building face dimension is less than 6.00 m, this dimension may be decreased to 1.00 m. In second and third degree earthquake zones,

the above mentioned wall shall have a minimum width of 1.00 m. Where the building height is less than 7.50 m and the building face dimension is less than 6.00 m, this dimension may be decreased to 0.80 m.

In interior bearing walls, the minimum distance between wall opening and the wall corner shall not be less than the thickness of the thicker of the intersecting walls.

Solid wall sections between windows and doors shall have a minimum width of 0.80 m in 1st degree earthquake zones, 0.60 m in 3rd degree earthquake zones. The width of such wall panels in any case shall not be less than 1/4 of the width of the larger opening. In the event where these limitations are not satisfied, reinforced concrete columns of sufficient section, bonded to floor beams, shall be provided at wall corners.

For openings larger than 3.00 m, a reinforced concrete frame of columns and a horizontal beam shall be provided.

In the case where the width of the wall exceeds 7.50 m between two consecutive cross-wall intersections, the wall thickness shall be increased and the wall panel supported by pilasters, as per calculations.

d) Partition and garden walls: Isolated walls or partition-walls not connected to other walls shall be made of at least 1/2 brick (11 cm) or 10 cm thick concrete blocks. In such walls cement mortar containing 250 kg cement per cubic meter of mortar shall be used.

Masonry garden walls shall not have a height exceeding 1.00 m above sidewalk level.

### 9.3. Slabs

Balconies, cornices and roof-slab extensions that are continuations of the floor slab shall not cantilever more than 1.50 m. Cantilever stairs shall not extend more than 1.10 m beyond the wall. Cantilever features at other levels than the floor level shall be anchored to a beam built in the wall and shall not extend beyond 1.00 m.

#### 9.4. Bond Beams and Lintels

Load bearing lintels above door and window openings shall be made to bear upon the wall for a distance of not less than 30 cms nor 0.2 times the span of the lintel. When lintels are not continuous like a bond beam, they shall be poured monolithically with the slab beam above.

Where slabs, including roof and stairway slabs are to be supported on bearing walls, reinforced concrete periphery beams of not less than 20 cms in depth and not narrower than the width of the supporting masonry wall or pier shall be provided. Such beams shall have a minimum longitudinal reinforcement of 4  $\phi$  10 bars and shall have  $\phi$  6 stirrups at 25cm o.c. The concrete for such beams shall have a cement content of not less than 300 kg/m<sup>3</sup>.

Bond beams having 4  $\phi$  10 reinforcement bars and  $\phi$  6 stirrups at 25 cm o.c. shall be provided in rubble walls for every 1.50 m of height, and in brick or concrete block bearing walls having heights in excess of 3.00 m, for every 2.50 m of height.

#### 9.5. Roof

Roof trusses shall be designed in such a way as to resist earthquake effects as a unit, and shall not transfer lateral loads other than wind or earthquake effects. Such trusses shall be securely anchored into the structure.

9.6. Above roof-slab level, metal or wood terrace railings, partition walls, penthouses with filler walls of non-masonry light weight material, stairway cells and water tanks not exceeding 5 tons capacity in each block may be constructed.

Where the penthouse area exceeds one-third of the building area, the penthouse shall be considered as a storey.

Parapet walls in terraces shall not be higher than 0.60 m.

In the case where partition walls exceed 2.00 m in height, they shall be reinforced with reinforced concrete bond beams.

Inclined bond beams shall have  $\phi$  6 dowel bars so as to connect roof purlins to such beams.

9.7. In earthquake zones, masonry arches and domes not conforming to aseismic design principles shall not be constructed.

#### Semi - Masonry Buildings

Section 10: Structures that differ from Masonry buildings only with respect to the "rigid floor slab" clause, shall hereafter be referred to as "semi-masonry structures".

Semi-masonry structures shall not be built higher than two storeys above the basement.

##### 10.1. Foundations

Construction of foundations shall comply with the requirements of Section 9.1 "Masonry Structures".

##### 10.2. Walls

a) Materials to be used for walls shall comply with the requirements of section 9.2a.

b) The number of storeys and the corresponding wall thickness are indicated in the following table.

c) Wall openings, partition and garden walls, bond beams and roofs shall comply with the requirements set for Masonry Buildings.

Minimum Wall Thickness (in cm) for all Earthquakes.

No. of Storeys including Basement	Rubble, Stone or Concrete	Brick	Solid Concrete Blocks
3	Basement	60	40
	Ground	50	40
	First	23	20
2	Basement	50	35
	Ground	50	23
	Ground	50	23
		23	20

## Timber Frame Structures

Section 11: Buildings having masonry foundation and/or basement walls, but having wood bearing storey walls and timber skeleton floor slabs shall hereafter be referred to as Timber Frame Structures.

Timber Frame Structures shall not be built higher than two storeys above basement. The clear height of any storey shall not exceed 3.00 metres.

### 11.1. Foundations

Construction of foundation shall comply with the requirements of section 9.1, "Masonry Structures".

### 11.2. Walls

a) In buildings with basements, basement exterior walls shall be at least 50 cm thick and shall not be higher than 2.40 metres. Basement partition walls may be built of brick or solid concrete blocks.

b) Ground storey floors shall be built of masonry or timber frame, 1st storey floor shall be built of timber frame. Construction of masonry walls shall comply with the requirements of Chapter 6, Section 9, Masonry Structures, Subsections 2a, 2b, 2c and 2d.

c) Skeletons for bearing walls shall consist of posts spaced not more than 1.50m apart, top and bottom beams placed above and below the posts, secondary beams between the posts and finally diagonal members forming triangular openings (Fig. 1). Openings in such timber frames shall be filled with material such as bricks, adobe clay, smaller pieces of timber, and the faces of the walls shall be covered by plaster on wire-mesh, timber lathes or bamboo-canes. The surface shall then be covered with wood panels or corrugated metal.

d) Posts and other vertical members shall not be lapped and they shall be connected to upper and lower beams and reinforced with nails as shown in Fig. 2.

e) Upper and lower beams may be spliced. Such splices shall be made as shown in Fig. 3 and shall be tied by bolts or nails having a length not less than the beam width.

f) All timber frames for bearing walls shall be connected to each other as shown in Figs. 4 and 5.

g) For one-storey buildings with or without basements and for the second storeys of buildings with masonry construction ground storeys, the minimum dimensions shall be; 10 x 10 cm for posts and vertical members, 5 x 10 cm for other frame members. For two-storey buildings where both storeys are made of timber frame walls, the minimum dimensions shall be; 12 x 12 cm for posts, vertical members and beams for the ground storey, 6 x 12 cm for other members.

h) Lateral and longitudinal walls in timber frame structures shall be made to intersect each other at not more than every 4.50 m. In the cases where interior partitioning does not satisfy this condition, bearing posts of the longitudinal wall shall be braced by diagonal members to the roof trusses at every 4.50 m. (Fig. 6)

i) In the case where both ground and first storey are of timber frame construction, interior partitions shall be made to coincide vertically.

j) Walls shall have solid panels with timber frame skeleton not less than 1.50 m at building corner and not less than 0.75 m between two openings.

Corner wedges shall be provided at top and bottom of posts as shown in Fig. 7.

### 11.3. Floors

Floor beams shall be made to bear upon timber heel beams at ground storey level and upon top chord beams of timber frames at first storey level. Such beams shall be nailed to the supporting member (Fig. 8).

Lateral bracing of elements not less than 5 x 10 cm in cross-section shall be provided at building corner as shown in Figs. 9, 10 and 11.

### 11.4. Bond Beams and Lintels

a) For buildings with masonry ground floors, bond beams and lintels shall conform with the requirements of masonry structures (Chapter 6, Section 4).

- b) In timber frame structures upper lintels for doors and upper and lower lintels for windows shall have the same dimensions of the posts and they shall be framed into the posts.

#### Adobe Buildings

Section 12: Buildings that have their foundations and basement walls made of rough stone and their bearing walls of cut or poured-in-place, unburned clayey earth shall hereafter be referred to as "Adobe Buildings".

##### 12.1. Foundations

a) Foundation walls shall be made of rough stone and shall have a minimum thickness of 0.50 m and shall have a minimum height of 0.50 m measured from the natural ground level. Binding material for such walls shall be lime mortar reinforced with 100 kg/m<sup>3</sup> of cement for 1st degree earthquake zones and lime mortar of 1:3 ratio in 2nd and 3rd degree earthquake zones. Foundation shall extend to solid bearing ground and shall be not shallower than 0.50 m. In buildings with basements, foundation depth may be reduced to 0.30 m.

b) In buildings with basements, basement walls shall not have a thickness less than 0.50 m nor a height more than 2.40 m. Foundation walls shall have a minimum thickness of 0.60 m. All such walls shall be made of rough stone and the binding material shall be as designated in Section 12.1a.

##### 12.2. Walls

- a) Soil to be used in making adobe blocks shall be inorganic and shall have a sufficient amount of clay and very little silt or loess.
- b) Adobe clay made by adding sufficient amount of straw, as determined by regional conditions, to adobe soil, shall be cured for a week after which the adobe blocks shall be cut or formed into layers and tamped.
- c) In rainy or frosty weather adobe blocks shall not be poured or cut, nor shall walls be built.

d) Minimum thickness of walls shall be not less than 1.5 adobe block for exterior walls, 1 adobe block for interior walls and storey height shall not exceed 2.70 m. Vertical joints of adobe blocks shall be staggered by at least 1/3 of the dimension of the block in the plane of the wall.

e) Openings in walls shall not exceed 2.10 x 1.00 m for doors and 1.40 x 0.90 width for windows.

A solid wall panel of at least 1.00 m wide shall be provided between wall corners and door or window openings. Between two consecutive openings a solid panel of width not less than two times the wall thickness shall be provided. In the case where openings are larger, timber posts of 10 x 10 cm cross-section shall be provided in pairs on both sides of the opening and such posts shall be connected to the bond beam and lintel below and above the window (Fig.12).

f) Bearing walls shall intersect at not less than 5.0 m.

g) Adobe blocks in walls shall be bonded by cured mortar used in adobe construction.

##### 12.3. Floors

Floors shall be made to bear upon and connected securely to bond beams on foundations or bond beams between basement walls and adobe block walls.

##### 12.4. Bond Beams

a) On foundation or basement walls, concrete bond beams of 0.15 m thickness and width of wall having 2  $\phi$  12 bars longitudinal reinforcement and having cement content of 250 kg/m<sup>3</sup> or timber bond beams of two 10 x 10 cm asphalt treated sections shall be provided (Figs.13 and 14). Timber bond beams shall be reinforced by transverse members of 5 x 10 cm sections nailed to 10 x 10 cm beams at every 1.50 m and the interior space shall be filled with crushed stone (Fig.15).

In adobe block walls timber bond beams, conforming with the requirements of "Adobe Buildings, Section 4a", shall be provided below and above windows, and on walls where roof beams or trusses are to bear.

Bond beams other than roof bond beams and door or window lintels, may be made of bamboo canes in regions where bamboo grows, spaced 5 cms apart and tied together at every 50 cms with a thin wire. Larger ends of such bamboo canes shall be crushed (Fig.16).

#### 12.5. Roofs

Roofs of adobe buildings shall be made to extend at least 0.50 m beyond the exterior walls. In 1st degree earthquake zones, flat earth roofs shall not be used on adobe buildings. In the case of a reinforced concrete plate roof, the roof shall be water-proofed

#### 12.6. Plasters

Exterior surfaces shall be plastered by adding lime to the adobe patty to protect the walls from external effects.

### CHAPTER 7

#### Repairs

Section 13: Buildings damaged by previous earthquakes shall be repaired according to design drawings prepared to provide sufficient strength against future earthquakes and approved by Building Authorities.

Section 14: Revisions, extensions or major repair in buildings in earthquake zones shall be made according to projects increasing the strength of the building against earthquakes and approved by Building Authorities.

Section 15: For chimney stacks in buildings in earthquake zones, the extension of the chimney beyond the roof slab level in reinforced concrete frame buildings and masonry buildings shall be at least 1 brick thick (23 cm). For chimneys in semi-masonry and timber-frame buildings this limitation shall apply to the complete height of the stack. Chimney stacks shall not be in contact with timber parts and shall be at least 0.05 cm away from timber parts. Chimneys shall be placed near the crest of the roof, or their height shall be calculated so as to conform with the pattern shown in Fig.17.

### CHAPTER 8

#### Method of Analysis for Aseismic Design of Buildings

Section 16: a.1. General Considerations: These lateral force requirements are intended to provide minimum values as design criteria toward making buildings in earthquake regions, resistive to lateral forces due to earthquakes. The provisions of this section apply to the building as a whole and also to all parts thereof, including the structural frame or walls, floor or roof systems, chimneys, warehouses, and other structural elements. Stresses shall be calculated as the effect of a force applied horizontally at each floor or roof level above the foundation. Horizontal forces shall be assumed to act along the principal axes of the building in each direction, but not simultaneously in both directions.

For buildings and other structures not complying with the definitions and principles of this section, it is tentatively recommended that similar general analyses and theoretical methods or experimental results be applied in lieu of the method of analysis described herein.

a.2. Earthquake Forces on Buildings: Each building shall be designed to resist the lateral forces acting along the principal axes and given by the following formula:

$$F = CW \quad (1)$$

where,

F = Total lateral earthquake force acting on the building (base shear value)

$$W = \sum W_i \quad (2)$$

Total weight of building

see section a.2.6 for  $W_i$

C =  $C_o \alpha \beta \gamma$ , seismic coefficient

$C_o$  = Seismic zone coefficient

$\alpha$  = Seismic soil coefficient

$\beta$  = Building importance coefficient

$\gamma$  = Building dynamic coefficient

a.2.1 Seismic Zone Coefficient  $C_o$  is given in Table 1

TABLE 1

Values of $C_o$ - Seismic Zone Coefficient*	
Zone	$C_o$
1	0.06
2	0.04
3	0.02

\*Values given in Table 1 are minimum values for  $C_o$

a.2.2 Seismic Soil Coefficient  $\alpha$  is given in Table 2.

TABLE 2

Soil Type	
1. Bedrock Bases	0.80
2. Compact bases (sand, gravel, hardpan clay, Fissured Rock Bases)	1.00
3. Loose soil containing water and poorer soils other than those indicated above	1.20

a.2.3 Importance parameter  $\beta$  is given in Table 3.

TABLE 3

Type of Building	$\beta$
- Buildings to be used during or immediately after an earthquake (Post Office, Fire Department, Power Station, Broadcasting, Pump Station, Hospitals etc.)	1.50
- Buildings housing valuable items (Museums)	
- Buildings and structures of High Occupancy (schools, stadiums, theaters, cinemas, religious temples, train stations, etc.)	1.00
- Buildings of low occupancy (private dwellings, Apartment Buildings, Hotels, Office Buildings, Restaurants, Industrial Buildings)	

a.2.4. Dynamic Coefficient

The value of  $\gamma$  is given in connection with natural period of vibration  $T$ , of the building in the following manner,

For  $T \leq 0.5$  sec,  $\gamma = 1$

For  $T \geq 0.5$  sec,  $\gamma = 0.5/T$  (3)

The value of  $\gamma$  calculated in this manner shall not be less than 0.3.

a.2.5. Calculation of Natural Period

In the absence of Experimental or Rigorous Dynamic Analysis, the value of  $T$  shall be calculated from,

$$T = 0.09H/\sqrt{D} \quad (4)$$

where,

$H$  = height of building in metres from Foundation Base

$D$  = width of building in metres in the direction of the acting lateral force.

a.2.6. Storey Weights to be used in the calculation of the lateral earthquake force shall be computed from the following formula,

$$W_i = G_i + \eta_i P_i \quad (5)$$

where,

$G_i$  = Total dead load on  $i$ th floor

$P_i$  = Total live load on  $i$ th floor

$\eta_i$  = Live load coefficient for  $i$ th floor

The values of  $\eta_i$  shall be taken as follows:

1. For theatres, schools, stadiums, warehouses, etc  $\eta = 1$ .

2. For hospitals, administrative buildings, hotels, apartment houses and private dwellings  $\eta = 0.50$ .

a.2.7. Earthquake and Wind Forces shall be assumed not to act simultaneously on the structure. In the computations for any structural element the larger effect due to earthquake or wind shall be used.



a.3. Total lateral load  $F$  shall be distributed along the height of the building as follows:

$$F_i = F \frac{W_i h_i}{\sum W_i h_i} \quad (6)$$

where,

$F_i$  = lateral force on  $i$ th floor

$W_i$  = weight of  $i$ th floor

$h_i$  = elevation of  $i$ th floor from foundation base.

#### 2.4. Allowable Stresses:

Allowable stresses for concrete and reinforcing steel may be increased not more than 50% when earthquake effects are considered.

Allowable soil bearing pressures, for soil classes indicated in a.2.2 Table 2, shall not be increased more than 50% for 1st class soils, and 30% for 2nd class soils. For 3rd class soils allowable bearing pressures shall not be increased.

a.5. In the calculation of soil pressures on retaining walls and buried curtain walls, the internal friction angle shall be decreased by  $6^\circ$  in 1st degree earthquake zones and by  $4^\circ$  in 2nd and 3rd degree earthquake zones.

a.6. For free walls connected to or independent of buildings, cantilever elements and balconies, ornamental facade stuccos and chimney stacks, the seismic coefficient shall be taken as three times the seismic coefficient of the buildings, in the most critical direction.

2.7. Horizontal Torsion Moments: In the cases where the eccentricity, at any storey, between the centre of mass and centre of rigidity exceeds 0.05 times the maximum plan dimension of the building at that storey, the increase in shear forces due to torsion shall be accounted for in the calculations. Torsional calculations may be based on static analysis.

## CHAPTER 9

Section 17: The previous earthquake code regulations, which appeared in the September 2, 1961 and No.19896 issue of the official Gazette are no longer in effect.

Section 18: These regulations become effective on the date of publication in the Gazette. (January 16, 1963, No.12301)

## ADDENDUM.

1. Old regulations may be used for structures for which a construction permit is obtained before January 16, 1968.

2. In first and second degree earthquake zones, reinforced concrete frame buildings having rib-slabs with or without concrete masonry filler blocks may be built, provided they comply with the following requirements.

a) Thickness of the floor plate shall not be less than 7 cm.

b) The width of a beam shall not exceed the dimension obtained as the sum of the supporting column or shear wall width and the depth of the beam itself.

c) Beam dimension shall be chosen so as not to require compressive reinforcement at any section. Punching stresses shall be investigated at beam-column intersections.

d) In structures where the building height above foundation level exceeds;

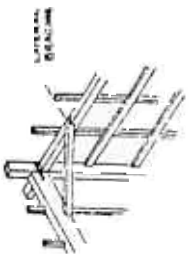
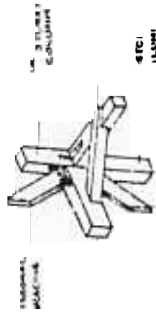
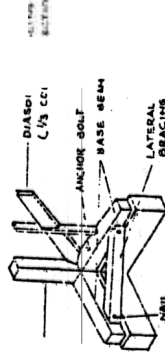
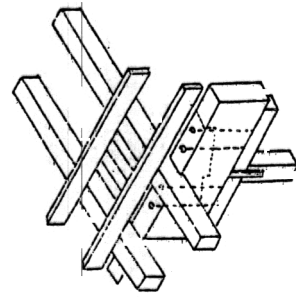
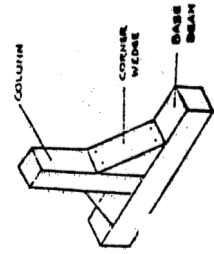
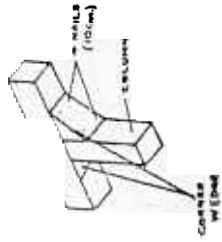
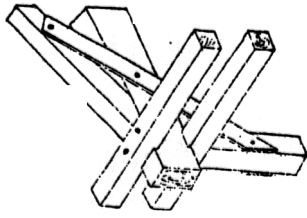
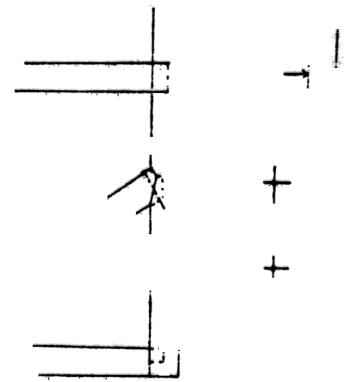
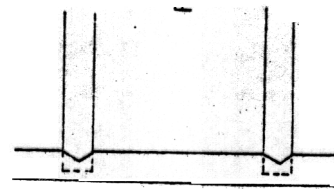
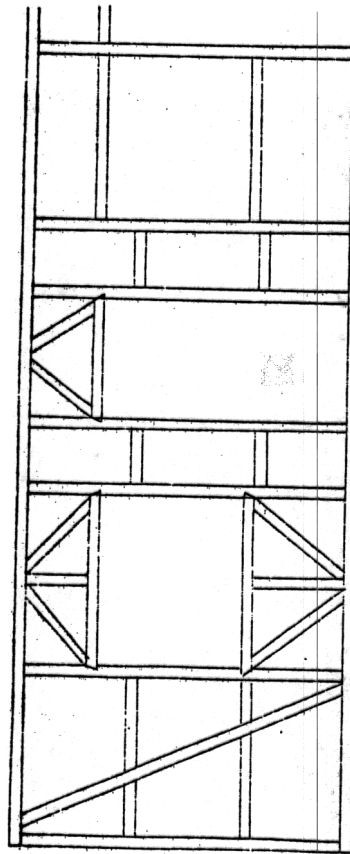
18.00 m in 3rd degree earthquake zones

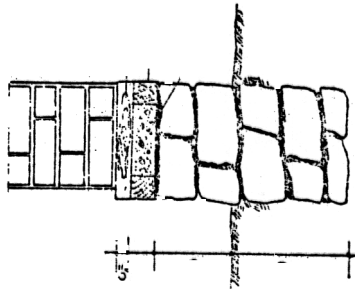
15.00 m in 2nd " " "

12.00 m in 1st " " "

shear walls extending along the height of the building shall be provided to transfer lateral earthquake loads to the foundations. Such walls shall be placed as symmetrically as possible with respect to the centre of mass of the building.

3. On bedrock grounds, foundation walls may be built on 10 cm concrete layers with no bond beams.





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