International Handbook of Earthquake Engineering

Codes, Programs, and Examples

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34

Turkey

Turan Durgunoğlu*

34.1 INTRODUCTION

Turkey is located in a region that has suffered frequent and intense seismic activity.[1] Seismic-resistant design is very important in order to prevent the kind of destruction that has occurred in cities and towns of the country.

The official code for earthquake-resistant design in Turkey is entitled *Specifications for Structures to be Built in Disaster Areas* (1975), a publication of the Turkish Government Ministry of Reconstruction and Resettlement, Earthquake Research Institute. This code has been in use since 1975 and is the current code for seismic design of buildings in the country. An updated version is in preparation, but is currently available only in draft form.

The material presented in this chapter, and the accompanying program, are based on the code of 1975. Parts I and II of the 1975 code are devoted, respectively, to general provisions and to design for protection against flood and fire. Part III deals with design for resistance to earthquakes.

34.2 GENERAL CONSIDERATIONS

The analysis and design of structures to resist earthquakes are based on a set of lateral static forces applied at the various levels of the building. The lateral forces are assumed to act independently first along one main axis of the building and then along the other axis. Where the principal axes of vertical resisting elements do not coincide with the main axes of the building, the possibility of very unfavorable conditions due to eccentric loading must be investigated. The lateral static forces stipulated by the code shall be considered minimum equivalent seismic forces applied to the

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[1] A list of the major earthquakes in Turkey since 1900 is given in Appendix A34 of this chapter.

entire structure. In the design of resisting elements of the building, it is not required to assume earthquake and wind loading acting simultaneously; the more unfavorable of these two loading conditions will control the final design.

Structures are classified by the code as regular or irregular. Regular structures are those in which the vertical resisting elements, columns and shear walls, extend continuously through the height of the building down to the foundation level. The static method of analysis in the code, based on equivalent lateral forces, is applicable only to regular structures with a clear height above the base level not exceeding 75 m. Irregularity in structures could be due to mass or stiffness irregularities either in plan or along the height of the building. The code requires all other structures to be designed using an appropriate dynamic method. Such dynamic analysis shall be based on the dynamic properties of both the structure and the underlying soil. The seismic responses may be found by using the modal superposition method in conjunction with real or idealized response spectra, by time integration of the pertinent equations of motion, or through the analysis of experimental results obtained from an appropriate model. The code stipulates that the total lateral force (base shear force) obtained from a dynamic method of analysis should not be less than 70% of the lateral force obtained by using the static method of analysis.

34.3 SEISMIC LATERAL FORCES

The total equivalent static force or base shear force V is given by

$$V = CW \tag{34.1}$$

where W is the total weight of the building calculated as the sum of the weight of the various levels; that is,

$$W = \sum_{i=1}^{N} W_i \tag{34.2}$$

with the weight W_i at level i determined as

$$W_i = G_i + \psi P_i \tag{34.3}$$

in which

G_i = total dead load at level i
P_i = total live load at level i
ψ = live load factor from Table 34.1

and C is the seismic coefficient defined as

$$C = C_0 KSI \tag{34.4}$$

Table 34.1. Live Load Factor (ψ)

Type of Structure	ψ
Warehouses, depots, etc.	0.80
Schools, student housing buildings, stadiums, cinemas, concert halls, garages, restaurants, commercial establishments, etc.	0.60
Private dwellings, hotels, hospitals, office buildings, etc.	0.30

Table 34.2. Seismic Zone Coefficient (C_0)

Seismic Zone	C_0
1	0.10
2	0.08
3	0.06
4	0.03

in which

C_0 = seismic zone coefficient
K = structural coefficient
S = spectral coefficient
I = structural importance coefficient.

34.3.1 Seismic Zone Coefficient C_0

The seismic zone coefficient C_0 is obtained from Table 34.2 on the basis of Seismic Zones 1 through 4. (See the seismic zone map of Turkey, Fig. 34.1.)

34.3.2 Structural Coefficient K

Values of the structural coefficient K are given in Table 34.3 for different types of buildings. The code stipulates that the coefficient K shall be not less than 1.0 for one- or two-story buildings.

34.3.3 Structural Importance Coefficient I

The structural importance coefficient I is given in Table 34.4. The value of this coefficient is based on the use of the building and on the need to maintain the functioning of governmental and emergency facilities after a disaster.

34.3.4 Spectral Coefficient S

The spectral coefficient S in eq.(34.4) is calculated by the following formula:

$$S = \frac{1}{0.8 + T - T_0} \leq 1.0 \tag{34.5}$$

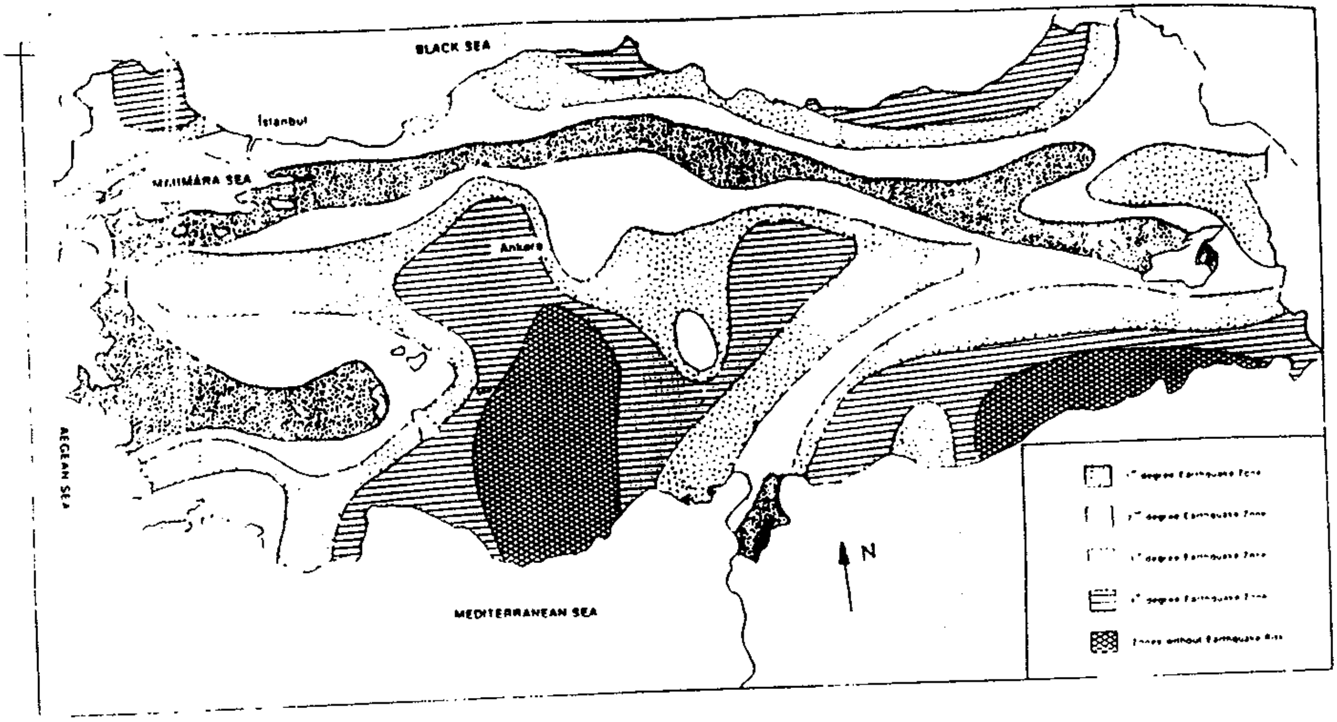


Fig. 34.1. Seismic zone map of Turkey

Table 34.3. Structural Coefficient (K)

Structural Type		K
All building framing systems not otherwise classified		1.00
Buildings with box systems with shear walls		1.33
Buildings with frame systems where the frame resists the total lateral force for filler wall types a. b. and c*		
1 Ductile moment resisting frames† (steel or reinforced concrete)	a)	0.60
	b)	0.80
	c)	1.00
2 Nonductile moment-resisting frames	a)	1.20
	b)	1.50
	c)	1.50
3 Steel space frames with diagonal bracing	a)	1.33
	b)	1.50
	c)	1.60
Shear wall systems with ductile frames capable of resisting at least 25% of the total lateral forces	a)	0.80
	b)	1.00
	c)	1.20
Masonry buildings		1.50
Elevated tanks not supported by a building		3.00
Structures other than buildings. towers. and chimney stacks		2.00

*Filler wall types.

a) Reinforced concrete or partition walls of masonry blocks with horizontal and vertical reinforcement.

b) Unreinforced masonry partition walls

c) Light and sparse partition walls or prefabricated concrete partition walls.

†Ductile moment-resisting frames are those structural frames designed and constructed with the potential capacity to sustain loads and dissipate energy in the inelastic range of deformations

where

T = fundamental period of the structure (in sec)
T_0 = predominant period of site (sec)

The code indicates that the value of S in eq.(34.4) need not be larger than 1.0. and that S shall be taken as 1.0 for masonry buildings. For different values of the predominant period of the site T_0. Fig. 34.2 shows a set of curves for the spectral coefficient S as a function of the period T [eq (34.5)]. The value of T_0 should be selected from Table 34.5 based on soil/rock

Table 34.4. Structural Importance Coefficient (I)

Structure Type	I
(a) Structures and buildings to be used during or immediately after an earthquake (post office. fire stations. broadcasting buildings. power stations. hospitals. stations and terminals refineries. etc.)	1.50
(b) Buildings housing valuable and important items (museums. etc.)	1.50
(c) Buildings and structures of high occupancy (schools. stadiums. theaters. cinemas. concert halls. religious temples. etc.)	1.50
(d) Buildings and structures of low occupancy (private dwellings. hotels. office buildings restaurants. industrial structures. etc.)	1.00

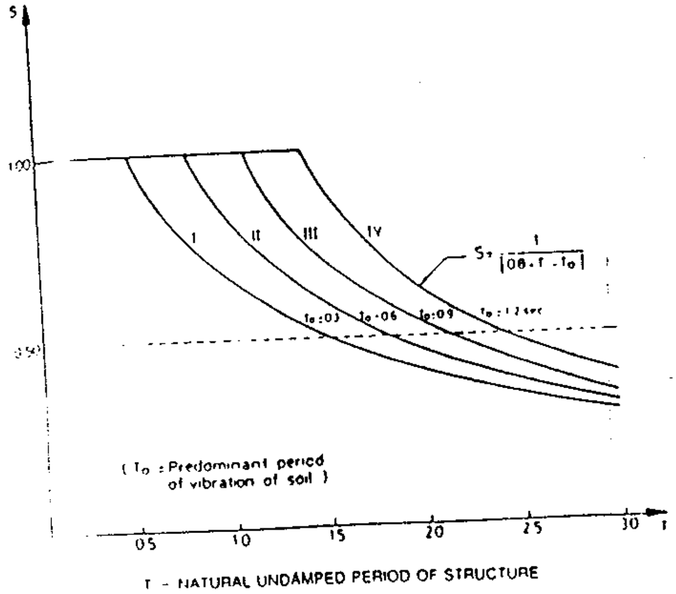


Fig. 34.2. Spectral coefficient in function of natural period for various types of soils defined by the predominant period of the soil

Table 34.5. Predominant Period T_0 for Soils Described in Table 34.6

Soil/Rock Class	Soil/Rock Types	T_0 Predominant Period of Site (sec)	T_0 Average (sec)
I	a	0.20	0.25
	b	0.25	
	c	0.30	
II	a	0.35	0.42
	b	0.40	
	c	0.50	
III	a	0.55	0.60
	b	0.60	
	c	0.65	
IV	a	0.70	0.80
	b	0.80	
	c	1.00	

class and soil/rock type as described in Table 34.6, unless it is determined by experimental, empirical, or theoretical principles based on valid assumptions and geological observations. Values obtained from Table 34.5 are valid only for the case where the layer of soil is directly above the bedrock or another rock-like formation, and has a thickness on the order of 50 m. Where the thickness of the layer of soil is greatly different from 50 m, the values of the shear wave velocity V_s of the soil stratum (in m/sec) and the thickness of the top layer soil stratum H (in m) shall be determined more accurately by field tests, empirical equations, or theoretical methods. For the latter

Table 34.6. Soil Classifications for Determination of Predominant Period T_0 in Table 34.5

Soil/Rock Class	Soil/Rock Types	N Blows per foot, Standard Penetration Test	D, Relative Density (%)	I, Unconfined Compressive Strength (kg/cm)	V, Shear Wave Velocity (m/sec)
I	(a) Massive and deep volcanic rocks; undecomposed, sound metamorphic rocks; very stiff cemented sedimentary rocks	NA	NA	NA	>700
	(b) Very dense sand	>50	85–100	NA	
	(c) Very stiff clay	>32	NA	>4	
II	(a) Loose magmatic rocks such as tuff or agglomerate, decomposed sedimentary rocks with planes of discontinuity	NA	NA	NA	400–700
	(b) Dense sand	30–50	65–85	NA	
	(c) Stiff clay	16–32	NA	2.0–4.0	
III	(a) Decomposed metamorphic rocks and soft cemented sedimentary rocks with planes of discontinuity	NA	NA	NA	200–400
	(b) Medium-dense sand	10–30	35–64	NA	
	(c) Silty clay	8–16	NA	1.0–2.0	
IV	(a) Soft and deep alluvial layers with a high water-table, marshlands or ground recovered from sea by mud filled, all fill layers	NA	NA	NA	<200
	(b) Loose sand	0–10	≤35	NA	
	(c) Clay, silty clay	0–8	NA		

NA Not Applicable

ituation, the value of T_0 shall be calculated by the quation

$$T_0 = \frac{4H_z}{V_s} \tag{34.6}$$

An accurate solution of such soil-related problems is selection of foundation type, determination of bearing capacity and settlements, as well as a realistic determination of the predominant period of vibration of the soil layer, requires an appropriate seismic exploration with laboratory experiments of the soil layer. Such an exploration shall be carried out for the following structures:

(a) Buildings having a height of more than 75 meters above foundation level
(b) Industrial structures with large spans, and buildings such as theaters, cinemas, etc.
(c) Towers, chimney stacks, elevated tanks, etc

Where the value of V_s cannot be determined accurately for use in eq.(34.6), the values for V_s given in Table 34.6 may be used. Where the underlying soil consists of a number of layers with different values of V_s, a separate value of T_0 shall be calculated for each and every layer. Soils that have a V_s value larger than 700 m/sec shall be assumed to be very sound; layers below that very sound layer need not be considered.

34.4 FUNDAMENTAL PERIOD

Unless obtained from experiments or by theoretical methods on the basis of valid assumptions, the value of the natural period T shall be calculated by both of the approximate relations that follow. The less favorable value of T given by eq.(34.7) or eq.(34.8) shall be used in eq.(34.5).

$$T = \frac{0.09H}{\sqrt{D}} \tag{34.7}$$

$$T = \lambda N \tag{34.8}$$

in which

H = height of structure above foundation level (in m)
D = dimension of building in a direction parallel to the applied lateral forces (m)
N = number of stories above foundation level
λ = coefficient determined by interpolation between the values of 0.07 and 0.10 according to the degree of general structural flexibility of the building (λ = 0.07 pertains to very rigid buildings; λ = 0.10 pertains to very flexible structures).

Equations (34.7) and (34.8) shall not apply to structures with large spans such as industrial buildings, cinemas, sports halls, and stadiums, or to buildings with regular bearing systems with a height of more than 34.0 m above foundation level such as chimney stacks, towers, and elevated tanks. The natural periods of such structures shall be calculated by a rigorous dynamic analysis where the properties of the soil and of the structure (soil-structure interaction) are taken into consideration.

34.5 VERTICAL DISTRIBUTION OF LATERAL FORCES

The base shear force V given by eq.(34.1) shall be distributed as lateral static forces F_i applied at the various levels of the building, according to the following relationships:

$$F_i = (V - F_t)\frac{W_i h_i}{\sum^{N} W_i h_i} \tag{34.9}$$

and

$$F_t = 0 \quad \text{for} \quad \left(\frac{H}{D}\right) \le 3$$

$$F_t = 0.004V\left(\frac{H}{D}\right)^2 \le 0.15V \quad \text{for} \quad \left(\frac{H}{D}\right) > 3 \tag{34.10}$$

in which

W_i = seismic weight at level i
h_i = height from the base of the building to level i
F_t = additional force applied at the top of the building
H = total height of the building
D = dimension of the building in the direction of the seismic forces

34.6 OVERTURNING MOMENTS

Overturning moments are determined by statics as the moments resulting from the seismic design forces F_i and F_t [eqs.(34.9) and (34.10)] that act on levels above the level under consideration. Hence, the overturning moment M_i at level i of the building is given by

$$M_i = F_t(h_N - h_i) + \sum_{j=i+1}^{N} F_j(h_j - h_i) \tag{34.11}$$

where i = 0, 1, 2, . . . , $N - 1$

34.7 TORSIONAL MOMENTS

he code requires that buildings be designed to resist horizontal torsional moments M_t due to the eccentricity or distance between the center of mass and the centers of stiffness of any floor, in addition to an accidental eccentricity e_0 of 5% of the largest plan dimension of the building perpendicular to the direction of the applied lateral forces.

34.8 APPURTENANCES AND/OR PARTS OF BUILDINGS

Earthquake loads acting on appurtenances and/or parts of buildings such as parapet walls, chimneys, cantilever elements, and balconies shall be calculated separately. In these calculations, the coefficient C as determined for the structure [eq.(34.4)], shall be increased threefold, and the lateral load V determined by eq.(34.1) shall be assumed to act at the center of mass of the appurtenance or element in the most unfavorable direction.

34.9 ALLOWABLE STRESSES

In the seismic-resistant design of members, the allowable stresses for concrete and steel may be increased by not more than 33% of the allowable values for static design. In reinforced concrete structures, an increase in bond stresses shall not be permitted. In steel structures, allowable stresses for all connections and joints shall not exceed the values for increased allowable stresses. The same requirement shall apply to the design of diagonal wind bracing and stability members. Whenever earthquake effects are considered, the allowable bearing pressures for subsoils may be increased by not more than 33% for Soil/Rock Classes I, II and III. No such increase shall be permitted for Class IV soils. Where the top foundation layer is of Class II, III, or IV, possible total settlements and/or differential settlements due to seismic vibrations should be determined, in addition to those settlements due to static loads. No increase in allowable stresses for concrete and reinforcing steel shall be permitted in foundations bearing directly on Class IV soils.

When designing retaining walls and sheet-pile walls with heights in excess of 6.00 m, the characteristics of the soil shall be determined by appropriate laboratory and field testing. In the calculation of earth pressure, the angle of shearing resistance shall be decreased by 6° in Seismic Zones 1 and 2, and by 4° in Seismic Zones 3 and 4.

34.10 EXAMPLE 34.1

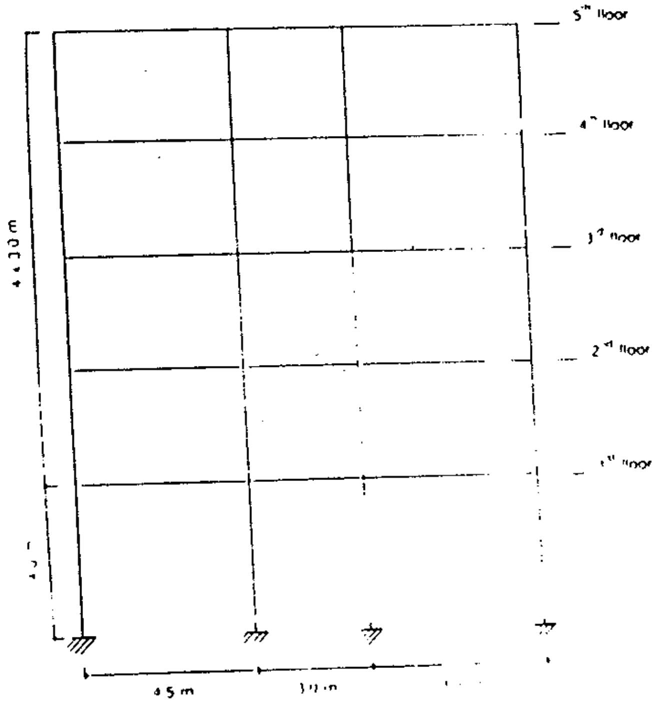
A five-story symmetrical reinforced concrete building is modeled as a plane frame (Fig. 34.3) with rigid horizontal diaphragms at the floor and top levels (shear building). The dead load is 131.90 tonnes at the first floor; 121.39 tonnes on the second, third, and fourth levels; and 115.08 tonnes on the fifth level. The live load is assumed to be 44.36 tonnes on all levels of the building, except at the roof level where it is zero. The underlying soil is medium-dense sand at a site in Seismic Zone 1 (Fig. 34.1). The building is to be used for governmental offices in which post-earthquake functioning is considered necessary.

Solution

1. Seismic weights

$$W_i = G_i + \psi P_i \qquad \text{[eq.(34.3)]}$$

$\psi = 0.3$ (From Table 34.1, office building)



	Elevation Above Foundation Base (m)	Total Dead Load (tons)	Total Live Load (tons)
1st floor	4.00	131.90	44.36
2nd floor	7.00	121.39	44.36
3rd floor	10.00	121.39	44.36
4th floor	13.00	121.39	44.36
5th floor	16.00	115.08	0.00

Fig. 34.3. Modeled building for Examples 34.1 and 34.2

Table 34.7. Forces, Moments and Displacements

Level i	Seismic Weight W_i (tonnes)	Force F_i (tonnes)	Story Shear V_i (tonnes)	Overturning Moment M_i (tonne-m)	Torsional Moment M_{ti} (tonne-m)	Story Drift Δ_i (mm)	Lateral Displacement δ_i (mm)
5	115.1	28.4	28.4	—	28.40	3.40	58.41
4	134.7	27.0	55.4	85.2	55.40	6.64	55.01
3	134.7	20.8	76.2	251.3	76.17	9.14	48.37
2	134.7	14.5	90.7	479.8	90.77	10.88	39.23
1	145.2	9.0	99.7	751.9	99.67	28.35	28.35
0				1,150.6			

$\Sigma W = 664.4$

Table 34.7 shows the values calculated for the seismic weights, W_i.

2. *Seismic zone coefficient*

$C_0 = 0.10$ (From Table 34.2, Seismic Zone 1)

3. *Structural coefficient*

$K = 1.0$ (From Table 34.3, framed system)

4. *Structural importance coefficient*

$I = 1.5$ (from Table 34.4)

5. *Natural period*

$$T = \frac{0.09H}{\sqrt{D}} = \frac{0.09 \times 16}{\sqrt{12}} = 0.42\,\text{sec} \qquad \text{[eq.(34.7)]}$$

or

$$T = \lambda N = 0.1 \times 5 = 0.5\,\text{sec} \qquad \text{[eq.(34.8)]}$$

(Assume $\lambda = 0.1$)

Select most unfavorable value: $T = 0.42$ sec.

6. *Predominant period of soil*

$T_0 = 0.6$ (from Tables 34.5 and 34.6 for Class III, Type b)

7. *Spectral coefficient*

$$S = \frac{1}{|0.8 + T - T_0|} \leq 1.0 \qquad \text{[eq.(34.5)]}$$

$$S = \frac{1}{0.8 + 0.42 - 0.6} = 1.61$$

$$= 1.0$$

8. *Seismic coefficient*

$$C = C_0 KSI \qquad \text{[eq.(34.4)]}$$

$$= 0.10 \times 1.0 \times 1.0 \times 1.5 = 0.15$$

9. *Base shear force*

$$V = CW \qquad \text{[eq.(34.1)]}$$

$W = 664.4\ T$ (from Table 34.7)

$$V = 0.15(664.4) = 99.7\ T$$

10. *Distribution of lateral seismic forces*

$$F_t = 0 \quad \text{for} \quad \frac{H}{D} = \frac{16}{12} = 1.33 < 3 \qquad \text{[eq.(34.10)]}$$

$$F_i = (V - F_t)\frac{W_i h_i}{\sum_{i=1}^{N} W_i h_i} \qquad \text{[eq.(34.9)]}$$

Table 34.7 shows the calculated seismic forces F_i for the various levels of the building.

11. *Story shear force*

$$V_i = \sum_{j=i}^{N} F_j$$

The calculated values are given in Table 34.7.

12. *Overturning moments*

$$M_i = F_N(h_N - h_i) + \sum_{j=i+1}^{N} F_j(h_j - h_i) \qquad \text{[eq.(34.11)]}$$

where $i = 0, 1, 2, \ldots, N - 1$.

13. *Torsional moments*

$M_{ti} = Ve_0$ (accidental eccentricity)

$e_0 = 0.05D = 0.05 \times 12\,\text{m} = 0.6\,\text{m}$

Calculated values of story shear force, overturning moment, and torsional moment are shown in Table 34.7.

14 *Story drift.* The interstory drift Δ_i, for a structure modeled as a shear building, is given by

$$\Delta_i = \frac{V_i}{k_i}$$

where

V_i = story shear force
k_i = story stiffness

$$k_i = \frac{12(EI)_i}{L_i^3}$$

$(EI)_i$ = total flexural stiffness of the story i
L_i = interstory height.

15 *Lateral displacements.* The lateral displacements δ_i of the building are calculated as

$$\delta_i = \sum_{j=1}^{i} \Delta_j$$

Table 34.7 shows the calculated values of story drift and lateral displacement.

34.11 COMPUTER PROGRAM

A computer program has been developed to implement the provisions of the Turkish seismic code of 19[illegible]. The program has provisions to either implement eqs. (34.7) and (34.8) to estimate the fundamental period of the structure or to input this value when it has been predetermined. The program calculates at each level of the building the seismic forces F_i, story shear forces V_i, overturning moments M_i, torsional moments M_{ti}, story drifts Δ_i, and lateral displacements δ_i.

Example 34.2

Use the computer program prepared for this chapter to solve Example 34.1.

34.11.1 Input Data and Output Results for Example 34.2

```
     INPUT DATA:

                                          NZ= 1
ZONE NUMBER                                I= 0
OCCUPANCY IMPORTANCE FACTOR                K= 1
STRUCTURAL FACTOR                        NIS= 3
SOIL PROFILE TYPE                       LAMB= .1
FACTOR LAMBDA                             LX= 3
LIVE LOAD FACTOR

     BUILDING DATA:

BUILDING DIMENSION, NORMAL TO FORCES (M)    DM= 20
BUILDING DIMENSION, FORCE DIRECTION (M)      D= 12
NUMBER OF STORIES                            N= 5

STORY #    HIGHT    FLEXURAL STIFFNESS  DEAD LOAD   LIVE LOAD
  I         (M)          (T M2)            (T)         (T)

   5       16.00       18750.00          115.10        0.00
   4       13.00       18750.00          121.39       44 36
   3       10.00       18750.00          121.39       44 36
   2        7.00       18750.00          121.39       44 36
   1        4.00       18750.00          131.90       44.36


     OUTPUT RESULTS:

   SEISMIC ZONE FACTOR  Z= .1
   FUNDAMENTAL PERIOD   T= .4156925
   SOIL PROFILE TYPE  NIS= 3
   SEISMIC FACTOR       C= .15
   DYNAMIC COEFFICIENT  S= 1

  TOTAL BASE SHEAR      V= 99.6603

    ASSUME ONLY ACCIDENTAL ECCENTRICITY (Y/N) ? Y


          DISTRIBUTION LATERAL FORCES, MOENTS AND DISPLACEMENTS
-----------------------------------------------------------------------------
LEVEL SEISMIC    LATERAL    SHEAR    OVERTURNING  TORSIONAL   STORY    LATERAL
      WEIGHT (T) FORCE (T) FORCE (T) MOMENT(T-M)  MOMENT(T-M) DRIFT(mm) DISPL.(mm)
-----------------------------------------------------------------------------
                                                   28 396     3 408    58 427
5     115.10      28.40     28.40                  55 396     6.648    55 020
4     134.70      27.00     55.40       85.19      76 166     9.140    48 372
3     134.70      20.77     76.17      251 38      90 704    10.885    39 232
2     134.70      14.54     90.70      479.87      99 660    28 348    28 348
1     145.21       8.96     99.66      751 99
0                                     1150.63
SUM= 664.40
-----------------------------------------------------------------------------
```

Example 34.3

Use the computer program developed from the 1975 Turkish code for seismic-resistant design to analyze the structure shown in Fig. 34.4.

34.11.2 Input Data and Output Results for Example 34.3

```
   INPUT DATA:
                                          NZ= 1
ZONE NUMBER                                I= 0
OCCUPANCY IMPORTANCE FACTOR                K= 1
STRUCTURAL FACTOR                        NIS= 3
SOIL PROFILE TYPE                       LAMB= .1
FACTOR LAMBDA                             LX= 3
LIVE LOAD FACTOR

     BUILDING DATA:

BUILDING DIMENSION, NORMAL TO FORCES (M)    DM= 26
BUILDING DIMENSION, FORCE DIRECTION (M)      D= 13
NUMBER OF STORIES                            N= 14

                                                     LIVE LOAD
STORY #    HIGHT    FLEXURAL STIFFNESS  DEAD LOAD       (T)
  I         (M)          (T M2)            (T)

                                                       9 00
  14       41.20       18750.00          40 00         9 00
  13       38.30       18750 00          44 00         9 00
  12       35.40       18750.00          44 00         9 00
  11       32.15       18750.00          44 00
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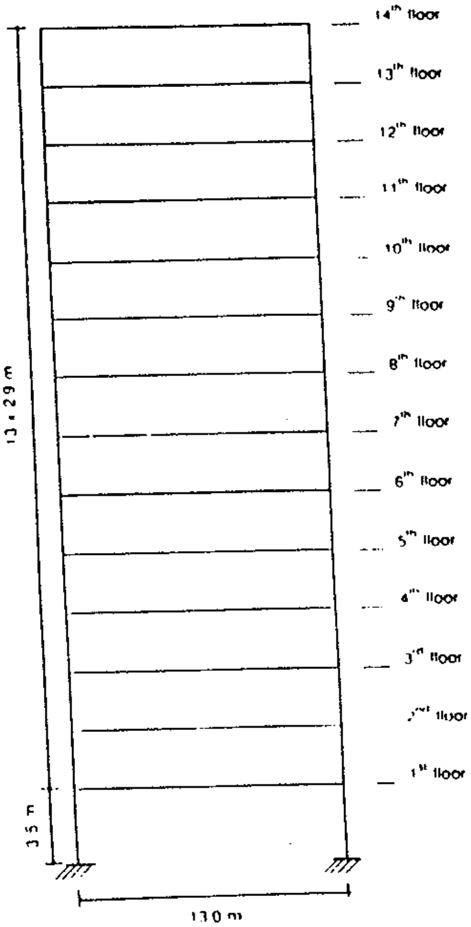

Fig. 34.4. Modeled building for Example 34.3

	Elevation Above Foundation Base (m)	Total Dead Load (tons)	Total Live Load (tons)
1st floor	3 50	44 0	28 0
2nd floor	6 40	44 0	28 0
3rd floor	9 30	44 0	28 0
4th floor	12 20	44 0	28 0
5th floor	15 10	44 0	28 0
6th floor	18 00	44 0	28 0
7th floor	20 90	44 0	28 0
8th floor	23 80	44 0	28 0
9th floor	26 70	44 0	28 0
10th floor	29 60	44 0	28 0
11th floor	32 15	44 0	28 0
12th floor	35 40	44 0	28 0
13th floor	38 30	44 0	28 0
14th floor	41 20	40 0	10 0

```
  10         29.60         18750.00        44.00       28.00
   9         26.70         18750.00        44.00       28.00
   8         23.80         18750.00        44.00       28.00
   7         20.90         18750.00        44.00       28.00
   6         18.00         18750.00        44.00       28.00
   5         15.10         18750.00        44.00       28.00
   4         12.20         18750.00        44.00       28.00
   3          9.30         18750.00        44.00       28.00
   2          6.40         18750.00        44.00       28.00
   1          3.50         18750.00        44.00       28.00


 OUTPUT RESULTS:

SEISMIC ZONE FACTOR  Z= .1

FUNDAMENTAL PERIOD   T= 1.028414
SOIL PROFILE TYPE  NI$= 3
SEISMIC FACTOR       C= .1221087
DYNAMIC COEFFICIENT  S= .8140577

TOTAL BASE SHEAR     V= 88.72417

 ASSUME ONLY ACCIDENTAL ECCENTRICITY (Y/N) ? Y
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              DISTRIBUTION LATERAL FORCES, MOENTS AND DISPLACEMENTS

                                                                    LATERAL
LEVEL SEISMIC    LATERAL    SHEAR     OVERTURNNING TORSTONAL  STORY    DISPL.(mm)
      WEIGHT (T) FORCE (T) FORCE (T) MOMENT(T-M)  MOMENT(T) DRIFT(mm)
                                                                    100.665
 14    45.40     13.46*     13.46          0.00     17.504     1.460    99.205
 13    52.40     10.62      24.09         39.05     31.314     2.611    96.594
 12    52.40      9.82      33.91        108.90     44.077     5.173    91.421
 11    52.40      8.92      42.82        219.10     55.669     3.156    88.265
 10    52.40      8.21      51.03        328.29     66.342     5.532    82.734
  9    52.40      7.41      58.44        476.29     75.969     6.334    76.399
  8    52.40      6.60      65.04        645.76     84.550     7.050    69.350
  7    52.40      5.80      70.84        834.37     92.086     7.678    61.671
  6    52.40      4.99      75.83       1039.79     98.576     8.219    53.452
  5    52.40      4.19      80.02       1259.69    104.020     8.673    44.779
  4    52.40      3.38      83.40       1491.73    108.419     9.040    35.739
  3    52.40      2.58      85.98       1733.59    111.772     9.320    26.419
  2    52.40      1.78      87.75       1982.93    114.079     9.512    16.907
  1    52.40      0.97      88.72       2237.41    115.341    16.907
  0                                     2547.95
_____________________________________________   _________________________
SUM= 726.6         *Including additional top force = 3.56
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REFERENCES

Turkish Government Ministry of Reconstruction and Resettlement (1972) *Seismic Zone Map of Turkey*. Ankara. Turkey.

—— (1975) *Specification for Structures to be Built in Disaster Areas*. Ankara. Turkey.

APPENDIX A.34 TURKISH EARTHQUAKE CATALOG (1900–1990) (KANDILLI OBSERVATORY/BOGAZICI UNIVERSITY)

Region Bounded: lat. 33°N–45°N
long. 23°E–48°E

Min. Magnitude: 6.0
Min. Acc. % g: 0.1

No	Day	Month	Year	Latitude	Longitude	Magnitude
1	[illegible]	4	1903	39.1	42.5	6.3
2	[illegible]	1	1905	39.6	23	6.0
3	[illegible]	12	1905	39	39	6.8
4	[illegible]	9	1906	40.5	42.7	6.2
5	[illegible]	12	1906	40.5	42	6.0
6	[illegible]	2	1908	37.4	35.8	6.0
7	[illegible]	5	1908	35.5	24	6.7
8	3	9	1908	38	44	6.0
9	[illegible]	2	1909	40	38	6.3
10	5	6	1910	41	34	6.2
11	9	4	1913	41.91	44.32	6.1
12	4	1	1916	40.27	36.83	7.1
13	[illegible]	8	1917	40.3	25.43	6.0
14	6	7	1918	36.08	26.99	6.1
15	29	9	1918	35.2	34.7	6.5
16	18	11	1919	39.26	26.71	7.0
17	1	8	1922	35.36	27.7	6.5
18	13	8	1922	35.51	27.98	6.9
19	13	9	1924	39.96	41.94	6.8
20	9	1	1925	41.33	43.41	6.0
21	1	3	1926	37.15	29.61	6.4
22	18	3	1926	35.99	30.13	6.8
23	26	6	1926	36.75	26.98	7.7
24	5	7	1926	36.52	26.69	6.2
25	22	10	1926	40.94	43.88	6.0
26	5	6	1927	36	31	6.2
27	31	3	1928	38.18	27.8	6.5
28	11	4	1928	42.34	26.02	6.8
29	2	5	1928	39.64	29.14	6.1
30	18	5	1929	40.2	37.9	6.1
31	[illegible]	3	1929	36.4	26.54	6.2
32	6	5	1930	37.98	44.48	7.6
33	8	5	1930	37.97	45	6.3
34	26	9	1932	40.39	23.81	7.1
35	29	9	1932	40.83	23.46	6.4
36	19	7	1933	38.19	29.79	6.0
37	9	11	1934	36.63	25.77	6.3
38	4	1	1935	40.4	27.49	6.4
39	4	1	1935	40.3	27.45	6.3
40	18	3	1935	35.33	26.83	6.5
41	1	5	1935	40.09	43.22	6.0
42	19	4	1938	39.44	33.79	6.6
43	22	9	1939	39.07	26.94	6.6
44	26	12	1939	39.8	39.51	7.9
45	7	5	1940	42.03	43.71	6.1
46	30	7	1940	39.64	35.25	6.2
47	20	12	1940	39.11	39.2	6.0
48	23	5	1941	37.07	28.21	6.0
49	8	11	1941	39.74	39.5	6.0
50	13	12	1941	37.13	28.06	6.5
51	21	6	1942	36.12	27.2	6.4
52	15	11	1942	39.55	28.58	6.1
53	11	12	1942	40.76	34.83	6.1
54	20	6	1943	40.85	30.51	6.5
55	16	10	1943	36.45	27.94	6.6
56	26	11	1943	41.05	33.72	7.2
57	1	2	1944	41.41	32.69	7.2
58	27	5	1944	36.23	27.25	6.2
59	25	6	1944	38.74	29	6.2
60	17	7	1944	35.91	42.55	6.1
61	6	10	1944	39.48	26.56	6.8
62	20	3	1945	37.11	35.7	6.0
63	2	9	1945	34.43	28.61	6.3
64	26	10	1945	41.54	33.29	6.0
65	16	7	1946	34.2	25.65	6.0
66	9	2	1948	35.41	27.2	7.1
67	23	7	1949	38.57	26.29	6.6
68	17	8	1949	39.57	40.62	7.0
69	13	8	1951	40.88	32.87	6.9
70	12	6	1952	34.67	26.56	6.0
71	17	12	1952	34.47	24.22	6.6
72	18	3	1953	39.99	27.36	7.2
73	7	9	1953	41.09	33.01	6.4
74	10	9	1953	34.8	32.5	6.3
75	16	7	1955	37.65	27.26	6.8
76	20	2	1956	39.89	30.49	6.4
77	9	7	1956	36.69	25.92	7.4
78	9	7	1956	36.59	25.86	6.5
79	30	7	1956	35.89	26.01	6.2
80	24	4	1957	36.43	28.63	6.8
81	25	4	1957	36.42	28.68	7.1
82	16	5	1957	40.67	31	7.1
83	15	9	1959	34.86	25.9	6.6
84	15	4	1960	40.5	42	6.0
85	23	5	1961	36.7	28.49	6.6
86	28	4	1962	36.03	26.87	6.0
87	16	7	1963	43.27	41.57	6.4
88	18	9	1963	40.77	29.12	6.3
89	14	6	1964	38.13	38.51	6.0
90	6	10	1964	40.3	28.23	7.0
91	9	3	1965	39.34	23.82	6.3
92	19	8	1966	39.17	41.56	6.9
93	20	8	1966	39.42	40.98	6.2
94	20	8	1966	39.16	40.7	6.1
95	4	3	1967	39.25	24.6	6.5
96	22	7	1967	40.67	30.69	7.2
97	26	7	1967	39.54	40.38	6.2
98	19	2	1968	39.4	24.94	7.2
99	3	9	1968	41.81	32.39	6.5
100	25	3	1969	39.25	28.44	6.0
101	28	3	1969	38.55	28.46	6.5
102	12	6	1969	34.43	25.04	6.2
103	28	3	1970	39.21	29.51	7.2
104	22	5	1971	38.85	40.52	6.8
105	4	5	1972	35.15	23.56	6.3
106	27	3	1975	40.45	26.12	6.7
107	6	9	1975	38.51	40.77	6.6
108	24	11	1976	39.05	44.04	6.1
109	11	9	1977	34.95	23.05	6.0
110	20	6	1978	40.78	23.24	6.4
111	25	2	1981	38.17	23.12	6.3
112	4	3	1981	38.24	23.26	6.4
113	19	12	1981	39.22	25.25	7.2
114	27	12	1981	38.91	24.92	6.5
115	18	1	1982	39.96	24.30	6.9
116	18	1	1982	40.03	24.56	6.8
117	6	8	1983	40.14	24.[illegible]	6.9
118	30	10	1983	40.35	42.[illegible]	6.8
119	7	12	1988	40.96	44.[illegible]	6.[illegible]