IMPACTS OF SOIL-STRUCTURE INTERACTION ON THE FUNDAMENTAL PERIOD OF SHEAR WALL DOMINANT BUILDINGS

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IMPACTS OF SOIL-STRUCTURE INTERACTION ON THE FUNDAMENTAL PERIOD OF SHEAR WALL DOMINANT BUILDINGS

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ABSTRACT

IMPACTS OF SOIL-STRUCTURE INTERACTION ON THE FUNDAMENTAL PERIOD OF SHEAR WALL DOMINANT BUILDINGS

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In many seismic design codes and provisions, such as Uniform Building Code and Turkish Seismic Code, prediction of fundamental period of shear-wall dominant buildings, constructed by tunnel form technique, to compute the anticipated seismic forces is achieved by empirical equations considering the height of the building and ratio of effective shear-wall area to first floor area as the primary predictor parameters. However, experimental and analytical studies have collectively indicated that these empirical formulas are incapable of predicting fundamental period of shear-wall dominant buildings, and consequently result in erroneous computation of design forces. To compensate for this deficiency, an effective yet simple formula has recently been developed by Balkaya and Kalkan (2004), and tested against the data from ambient surveys on existing shear-wall dominant buildings. In this study, previously developed predictive equation is modified to include the effects of soil-structure interaction on the fundamental period. For that purpose, 140 shear-wall dominant buildings having a variety of plans, heights and wall-configurations were re-analyzed for four different soil conditions classified according to NEHRP. The soil effects on the foundation were represented by the translational and rotational springs, and their rigidities were evaluated from foundation size and elastic uniform compressibility of soil. Based on the comprehensive study conducted, improved prediction of fundamental period is achieved. The error in predictions on average is about 15 percent, and lending further credibility to modified formula considering soil-structure interaction to be used in engineering practice.

Keywords: shear wall; fundamental period; tunnel form technique; soil-structure interaction; finite-element modeling

ÖZ

TÜNEL KALIP TEKNİĞİ İLE İNŞA EDİLEN PERDE DUVARLI YAPILARDA ZEMİN-YAPI ETKİLEŞİMİNİN DOĞAL SALINIM PERİYODUNA OLAN ETKİLERİ

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Aralarında Türkiye'de halen yürürlükte olan deprem şartnamesi ve UBC97'ninde bulunduğu birçok deprem şartnamesinde, perde duvarlı yapıların sismik kuvvetlerinin hesaplanabilmesi için bina yüksekliğinin ve etkili perde duvar alanının binanın ilk kat alanına oranı gibi ana parametrelerin kullanıldığı, binanın doğal salınımının tahmini için kullanılan ampirik formüller bulunmaktadır. Fakat, deneysel ve analitik çalışmalar göstermiştir ki; yapılardaki doğal salınım periyodunun hesabı için öngörülen ampirik formüller yetersiz kalmaktadır ve deprem yüklerinin hesaplanmasında hatalı ve yanıltıcı sonuçlara neden olmaktadır. Bu eksikliği telafi etmek için son zamanlarda Balkaya ve Kalkan (2004) tarafından etkili ve basit bir formül geliştirilmiş ve bu formül mevcut tünel kalıp tekniği ile inşa edilen perde duvarlı yapılardan elde edilen verilerle test edilmiştir. Bu çalışmada, önceden geliştirilmiş olan bu formül, zemin-yapı etkileşiminin yapının doğal salınım periyoduna olan etkilerini görmek amacı ile yeniden düzenlenmiştir. Bu amaçla, tünel kalıp tekniği ile inşa edilen aralarında bir çok plan, yükseklik ve duvar konfigürasyonunun bulunduğu 140 bina NEHRP'e göre sınıflandırılmış dört farklı zemin grubu için yeniden incelenmiştir. Zeminin temel üzerindeki etkisi düşey ve dönme yaylarıyla modellenmiş ve yay rijitlikleri temel boyutları ve zemin yatak katsayısı kullanılarak hesaplanmıştır. Yapılan ayrıntılı çalışmaların sonucunda yapıların doğal salınım periyodunu tahmin etmek için kullanılan formül geliştirilmiştir. Periyod tahminlerindeki hata oranı ortalama yüzde 15 civarında kalmış ve zemin-yapı etkileşimini dikkate alan yeni formulün güvenilirliği mühendislik uygulamalarına bırakılmıştır.

Anahtar Kelimeler: perde duvar; doğal salınım periyodu; tünel kalıp sistemi;
yapı-zemin etkileşimi, sonlu elemanlar yöntemi

To My Parents

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a	Estimator parameter
f_{c28}	Characteristic compressive strength of 28-day-old concrete, t/m^2
h	Height of the building, m
h_n	Height of the building, m
k_c	Translational stiffness of the foundation
k_q	Rotational stiffness of the foundation
$\overline{s_u}$	Undrained shear strength of the soil, psf
$\overline{n_s}$	Average shear wave velocity of the soil, ft/sec
u	Poisson ratio of concrete
w	Water content
A_e	The minimum cross-sectional area in any horizontal plane in the first story in m^2 of a shear-wall
C	Estimator parameter
C_u	Elastic uniform compressibility of the soil, kN/m^3
D	Estimator parameter
D_e	The length of a shear-wall in the first story in the direction parallel to the applied forces, m
E	Estimator parameter
E	Modulus of elasticity of concrete, t/m^2
F	Estimator parameter
I_{OF}	Moment of inertia of the foundation, m^4
M_w	Moment Magnitude
$\overline{N}$	SPT (Standard Penetration Test) blow count
PI	Plasticity index
R	The ratio of long side dimension to short side dimension of the building

R_F	The ratio of moment of inertia of foundation in strong axes to weak axes ($R_F \geq 1$)
R_{length}	The ratio of shear-wall area oriented along the length to a typical story area
R_{width}	The ratio of shear-wall area oriented along the width to typical story area
T	Fundamental period of the structure, s

CHAPTER 1

INTRODUCTION

1.1. GENERAL

Shear-wall dominant multi-story reinforced concrete structures, constructed by tunnel form techniques, are one of the common structural types in regions facing high seismic risk due to buildings' inherent resistance and ease of construction. Although they have been increasingly constructed worldwide, limited research has been conducted to their analysis, design and safety.

Shear-wall dominant buildings, constructed by using tunnel form techniques, are composed of vertical and horizontal panels set at right angles and supported by struts and props. Shear-wall dominant buildings diverge from the other conventional reinforced concrete (RC) structures due to lack of beams and columns. The main components of a tunnel form system are its relatively thinner shear-walls and flat-slabs compared to those of traditional RC buildings. The construction details and typical implementation of tunnel form system are shown in Figure 1.1. In a tunnel form system, pre-cast RC stairs and outside panels are commonly used in order to ease construction, whereas load carrying pre-cast members are avoided. Continuity of shear-walls throughout the height is recommended to avoid local stress concentrations and to minimize torsion. Such a strict shear-wall configuration in the plan and throughout the height of the building may limit the interior space use from an architectural point of view, and this is one of the disadvantages of tunnel form buildings.

The walls and slabs, having the same thickness are cast in their place in a single operation. This reduces not only the number of cold-formed joints, but also the assembly time. The simultaneous casting of walls, slabs and cross-walls results in monolithic structures, which provide high seismic performance by retarding the plastic hinge formations at the most critical locations, such as slab-wall connections and around openings. In addition to their considerable resistance, the speed and ease

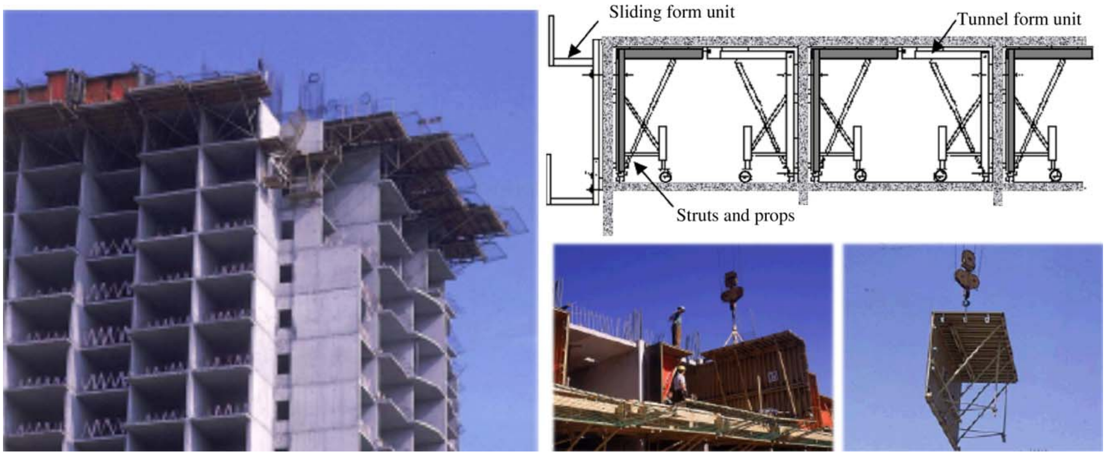

Figure 1.1 Tunnel form construction technique and its special formwork system [1]

of building make them preferable as the multi-unit construction of public and residential buildings.

Seismic performances of shear-wall dominant buildings have been observed during earthquake in Turkey in 1999. These earthquakes caused considerable structural damage and loss of life. However, in contrast to heavily damaged conditions of many RC buildings, neither demolished nor damaged shear-wall dominant buildings were reported.

Although shear-wall dominant structures demonstrated excellent behavior under earthquake excitations, the current seismic provisions and codes (such as Uniform Building Code, UBC [2], and Turkish Seismic Code, TSC [3]) constitute inadequate guidelines for their detailed analysis and design.

In many years, a few 3-D experimental and analytical researches have been performed to estimate the fundamental period of shear-wall dominant structures since the simplified formulas given by the building codes are developed from statistical data and they are of an empirical nature. A new experimental formula has been developed by Lee, Chang and Chun [4]. In their study, full scale measurements were carried out on fifty RC apartment buildings and these results were compared with those obtained by code formulas and also by dynamic analysis [4]. They realized that when code-given formulas are used, comparatively large errors are likely to occur, because it gives a period much shorter in the longitudinal direction and longer in the transverse direction than obtained from dynamic analysis [4]. Recently, a simple formula has been developed by Balkaya and Kalkan [1]. They have analyzed 140 shear-wall dominant buildings to estimate the fundamental period of tunnel form buildings having stories 5-25. They have concluded that code-equations may lead to intolerable errors in estimating the periods of tunnel form buildings and consequently anticipated design loads for their reliable seismic design [1].

The fundamental period calculated using empirical formulas, given by the building codes, should be used as an estimation of fundamental period of the structure; significant precision is not an objective. The equations provided by codes are intentionally calibrated to underestimate the period in order that a conservative base shear is obtained. To keep the empirical formula simple, only the structural system is taken into account with no specification regarding the soil characteristics on which the building is expected to be built [5]. Therefore, an experimental study was performed by Ghrib and Mamedov [5] in order to estimate fundamental periods of shear-wall dominant structures with flexible bases. Twenty buildings built on different types of soil are tested under ambient vibration. The results have shown that fundamental period formula given in UBC is inadequate since it does not include the effect of foundation stiffness [5].

In order to compensate for the deficiency of building codes, it is essential to describe the impacts of soil-structure interaction on the fundamental period of shear-wall dominant buildings to obtain improved prediction of fundamental period, and consequently improved seismic forces.

1.2. OBJECT AND SCOPE

The primary purpose of this study is to evaluate the code-based empirical formulas to estimate the fundamental period of shear-wall dominant buildings and to improve the previously developed predictive equation by Balkaya and Kalkan (2004) by including the effects of soil-structure interaction on the fundamental period of shear-wall dominant buildings. This thesis is intended to serve as a reference for the prediction of fundamental period and design of shear-wall dominant buildings.

1.3. ORGANIZATION AND CONTENTS

This thesis is divided into 4 chapters. Chapter 1 is the introductory part describing the shear-wall dominant buildings. Chapter 2 deals with the structural importance of shear-wall dominant buildings and detailed information about the fundamental period formulas of shear-wall dominant structures given in current code provisions. Chapter 3 provides general information about the analytical modeling of structures and assumptions made in the dynamic analysis. In Chapter 4, the results of the dynamic analysis performed for four different soil conditions and estimation of fundamental period formula for shear-wall dominant buildings with and without soil-structure effects are presented. Concluding remarks and discussions, brief summary and future recommendations are presented in Chapter 5.

CHAPTER 2

BEHAVIOR OF SHEAR WALL DOMINANT BUILDINGS

2.1. STRUCTURAL IMPORTANCE OF SHEAR WALL DOMINANT BUILDINGS

A desirable characteristic in an earthquake-resistant structure is the ability to respond to strong motion by progressively mobilizing the energy-dissipative capacities of an ascending hierarchy of elements making up the structure [6]. In that perspective, properly designed shear walls in multi-storey structures are very effective in reducing the inner-storey drifts under earthquake excitations. Their good seismic performances have been observed during earthquakes in Turkey in 1999. Therefore, monolithic casting of shear walls and slabs provides high seismic performance in shear wall-dominant systems. This conclusion was also experienced from the results obtained by three-dimensional non-linear seismic performance evaluations of tunnel form buildings by Balkaya and Kalkan [7]. Since shear walls and slabs have the same thickness in contrast to those of standard building slabs, it is recommended to keep the rigid floor assumption out of modeling, discussed by Fleischman and Farrow [8] and Tena-Colunga and Abrams [9].

Transverse walls which are perpendicular to the main walls and the loading direction provide extra resistance and significantly increase the predicted load capacity as a result of tension/compression (T/C) coupling effect produced by in-plane or membrane forces in the walls even though their connection to main wall rather loose [6]. The lateral walls form a system with in-plane walls similar to a typical T-section whose behavior through its 3-D effects is similar to the section above the opening in the walls in the loading direction having a T-section contribution from the floor slabs a shown in Figure 1.2 [6]. Balkaya and Schnobrich (1993) stated that

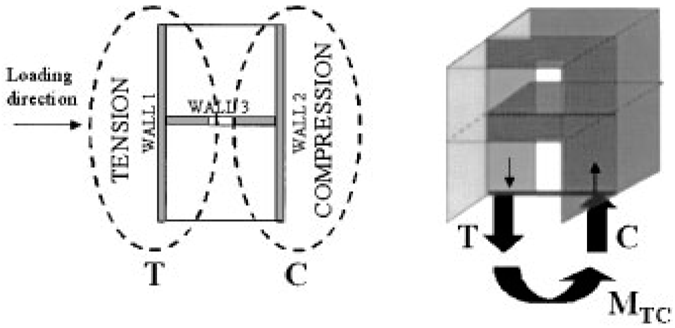

Figure 2.1 Slab-wall interaction due to tension and compression (T/C) coupling [6]

the structural systems with these wall-to-wall and wall-to-slab interactions increase their lateral load capacity as well as their performance under earthquake forces [10].

In contrast to their high performance under earthquake forces, one observed handicap of this special structural type is their torsional behavior, unless an appropriate side ratio is selected and shear walls are configured properly in the architectural plan [6]. Balkaya and Kalkan (2003) concluded that close to square architectural plans and symmetrically located shear walls are recommended in order to minimize torsional disturbances.

2.2. FUNDAMENTAL PERIOD EQUATIONS IN CURRENT SEISMIC CODE PROVISIONS

In current seismic code provisions, fundamental period of the building is one of the main parameters in the calculation of earthquake forces acting on structure. The fundamental period of a building is used to calculate the design base shear and lateral forces based on the design spectrum. Therefore, correct estimation of fundamental periods of buildings is inevitably essential to obtain earthquake forces. In this thesis, formulas for estimating the fundamental period given in Uniform Building Code, UBC [2] and Turkish Seismic Code, TSC [3] were examined. TSC concerning construction in seismic areas has been recently modified in 1998. In TSC, the equation for predicting the fundamental period of structures was directly taken from the UBC (1997) with small modifications. The general form of the equation given in these provisions is as follows (equations are in SI unit system):

$$T = C_t (h_n)^{3/4} \tag{1.1}$$

Where T is the period in seconds; h_n is the height of the building in meters; C_t = 0.0853 (0.08) for steel frames, C_t = 0.0731 (0.07) for reinforced concrete moment-resisting frames and eccentrically braced frames, and C_t = 0.0488 (0.05) for all other buildings. Alternatively, the value of C_t for structures where seismic loads are fully resisted by reinforced concrete structural walls, can be taken as 0.0743 (0.075)/$(A_c)^{1/2}$ ($\leq$0.05). The numbers within the parentheses show the corresponding values given in the TSC. The value of A_c can be calculated from the following formula:

$$A_c = \sum A_e \left[0.2 + (D_e / h_n)^2 \right] \tag{1.2}$$

Where A_e is the minimum cross-sectional area in any horizontal plane in the first story in meter^2 of a shear-wall; D_e is the length, in meter, of a shear-wall in the first story in the direction parallel to the applied forces. The value of D_e / h_n used in Eq. 1.2 should not exceed 0.9.

In Turkish Seismic Code (TSC) [3], the first natural vibration period may be calculated by Eq.1.1 in all buildings to which Equivalent Seismic Load Method is applied. On the other hand, the usage of Eq.1.1 for the calculation of the first natural period is permitted for buildings with $h_n \leq$ 25m in the first and second seismic zones and for all buildings to which Equivalent Seismic Load Method is applied in the third and fourth seismic zones.

In Uniform Building Code (UBC) [2], the usage of Eq.1.1 for the determination of the first natural period, to be used in the calculation of static lateral force, is permitted for all structures, regular or irregular, in seismic zone 1 and in occupancy categories 4 and 5 in seismic zone 2, for regular structures under 240 feet (73 m) in height and for irregular structures not more than five stories or 65 feet (19 m) in height.

In this study, the validity of the empirical equations given in current seismic code provisions to estimate the fundamental periods of buildings will be examined since only the height of the building and ratio of effective shear-wall area to first floor area are taken into account in the empirical equations given in current seismic code provisions. Although soil-structure interaction has a great impact on the fundamental period of the buildings, in the current seismic code provisions to keep the empirical formula simple only structural system is taken into account with no specifications regarding on the soil characteristics on which the building is to be built.

CHAPTER 3

ANALYTICAL MODELING OF STRUCTURES

3.1. GENERAL

In this study, the consistency of design criteria for shear-wall dominant structures given by UBC (1997) and TSC (1998) are investigated. Although these buildings show high resistance to earthquake excitations due to their discrete structural and load transferring systems, the general trend is towards their acceptance as conventional RC frame type shear wall buildings. Because of that reason, the reliability of given empirical equations to define dynamic properties for these structures are examined and it is shown that these empirical code formulas for estimating the fundamental period of these structures are grossly inadequate and give unreliable results.

In order to estimate the fundamental period of shear-wall dominant structures explicitly, a predictive equation was proposed by Balkaya and Kalkan (2004). This equation and the values of its estimating parameters were developed by an extensive three-dimensional finite-element analysis of 20 selected different plans for seven different building heights (storey levels: 5, 10, 12, 15, 18, 20, 25). The database obtained constituted the analysis of 140 different case studies and the calculations of their basic properties. The empirical equation for predicting the fundamental period of tunnel form structures was typically fit to this data set by applying non-linear regression analysis.

Within the framework of this study, 140 shear-wall dominant buildings having variety of plans, heights and wall-configurations were re-analyzed for four different soil conditions classified according to NEHRP [11]. Based on the comprehensive study conducted, previously developed predictive equation was modified to include the soil-structure interaction on the fundamental period.

3.2. DATABASE AND ANALYTICAL MODELING

In order to obtain a representative database for the analysis, as-built plans are intentionally selected. All structural elements including shear walls, floor slabs and foundation slab are three dimensionally modeled by using finite-element modeling using shell elements. All elevator and staircase hollows and door openings are considered. Diaphragm flexibility was taken into account without making any rigid-floor assumption [6].

The database constitutes 20 different plans for seven different story levels (i.e., 5, 10, 12, 15, 18, 20, 25). Shear-wall thickness was taken as 12 cm for buildings up to 15-story, 15cm for 18-story buildings and 20 cm for 20- and 25-story buildings. Thickness of floor slab was taken as 12 cm for all buildings.

In contrast to previous models developed by Balkaya and Kalkan (2004), mat foundations under shear-walls were introduced to the models. Foundation slab thickness was taken as 30 cm for 5-story, 60 cm for 10-story, 70 cm for 12-story, 90 cm for 15-story, 110 cm for 18-story, 120 cm for 20-story and 150 cm for 25-story buildings. The foundation dimensions were selected to be 1 m longer than the plan dimensions in all sides. The foundation slabs were simulated by finite elements having both flexural and membrane capabilities. The soil effects on foundation were represented by translational and rotational springs.

The three-dimensional finite-element dynamic analysis of 140 shear-wall dominant buildings for four different soil conditions were performed by using ETABS [12]. Selective typical plan and elevations in the database are provided in the following pages to illuminate their architectural and structural concepts. In these figures solid lines demonstrate the shear walls in the plan. The typical three-dimensional mesh model is given in Figure 3.3 for a five-storey building (Plan No. 2). Remaining plans in the database are illustrated in Appendix-A.

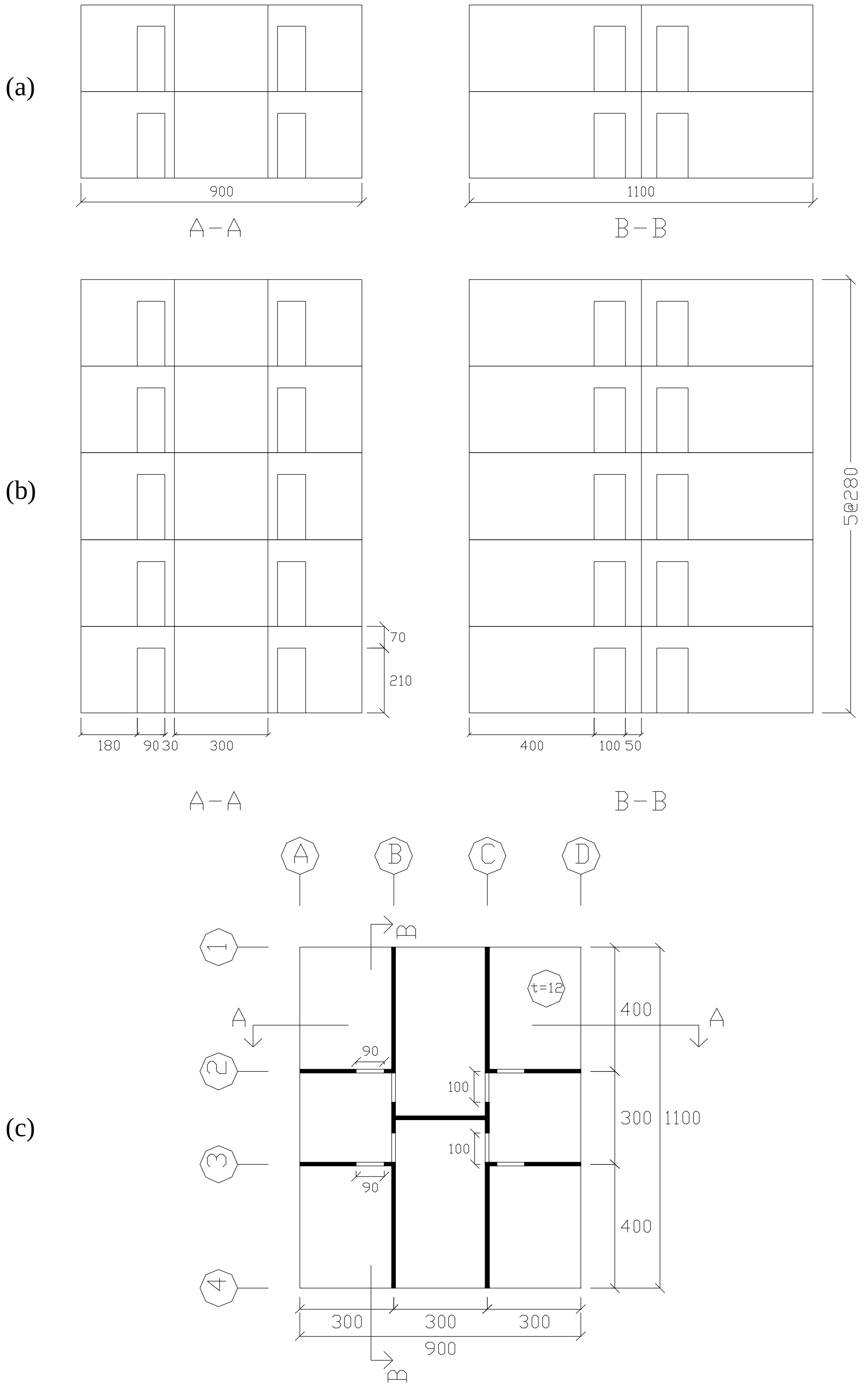

Figure 3.1 Typical plan and elevations for 2- and 5-story buildings – Plan No. 11 (units in cm). (a) 2-story elevation; (b) 5-story elevation; (c) plan view

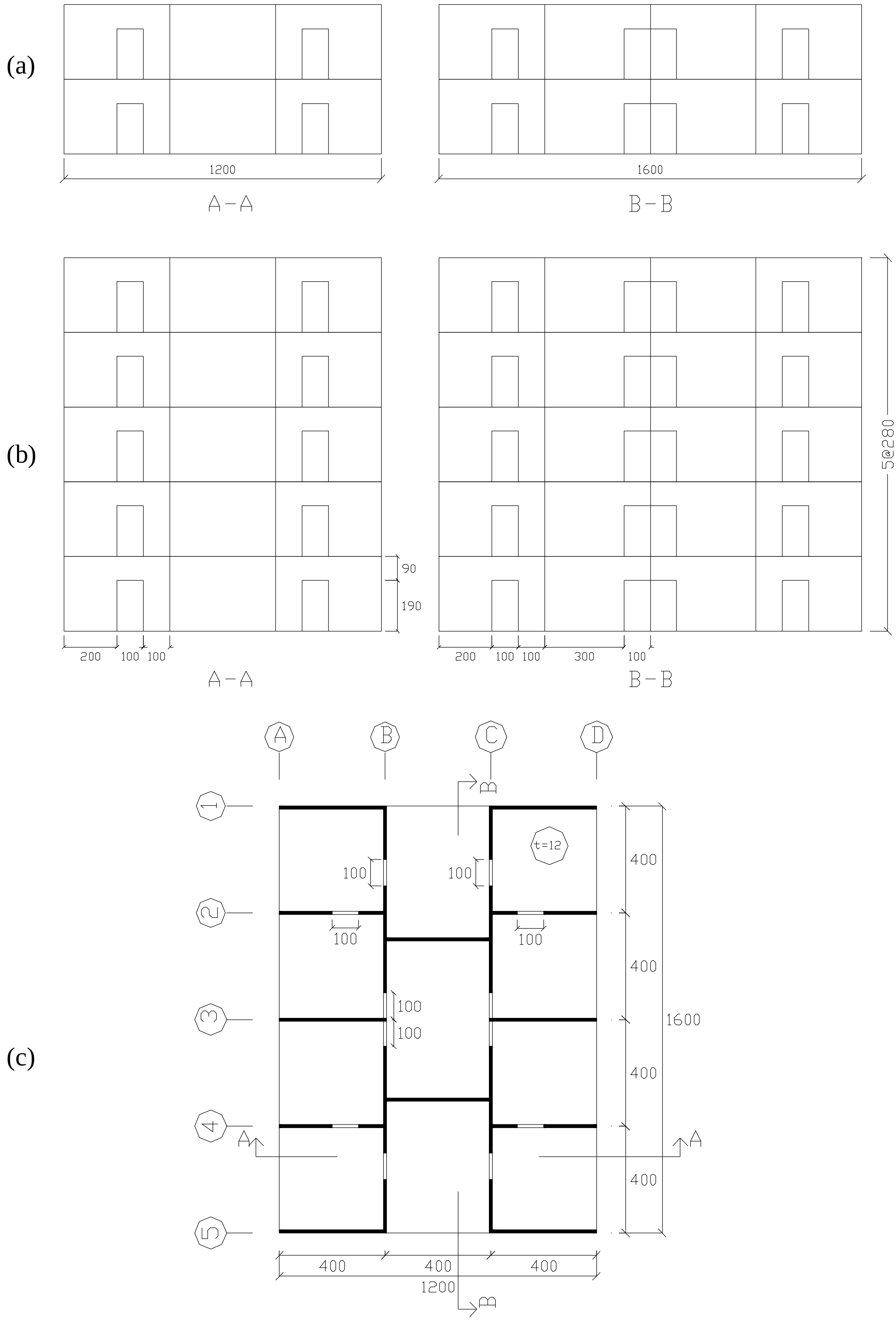

Figure 3.2 Typical plan and elevations for 2- and 5-story buildings – Plan No. 20 (units in cm). (a) 2-story elevation; (b) 5-story elevation; (c) plan view

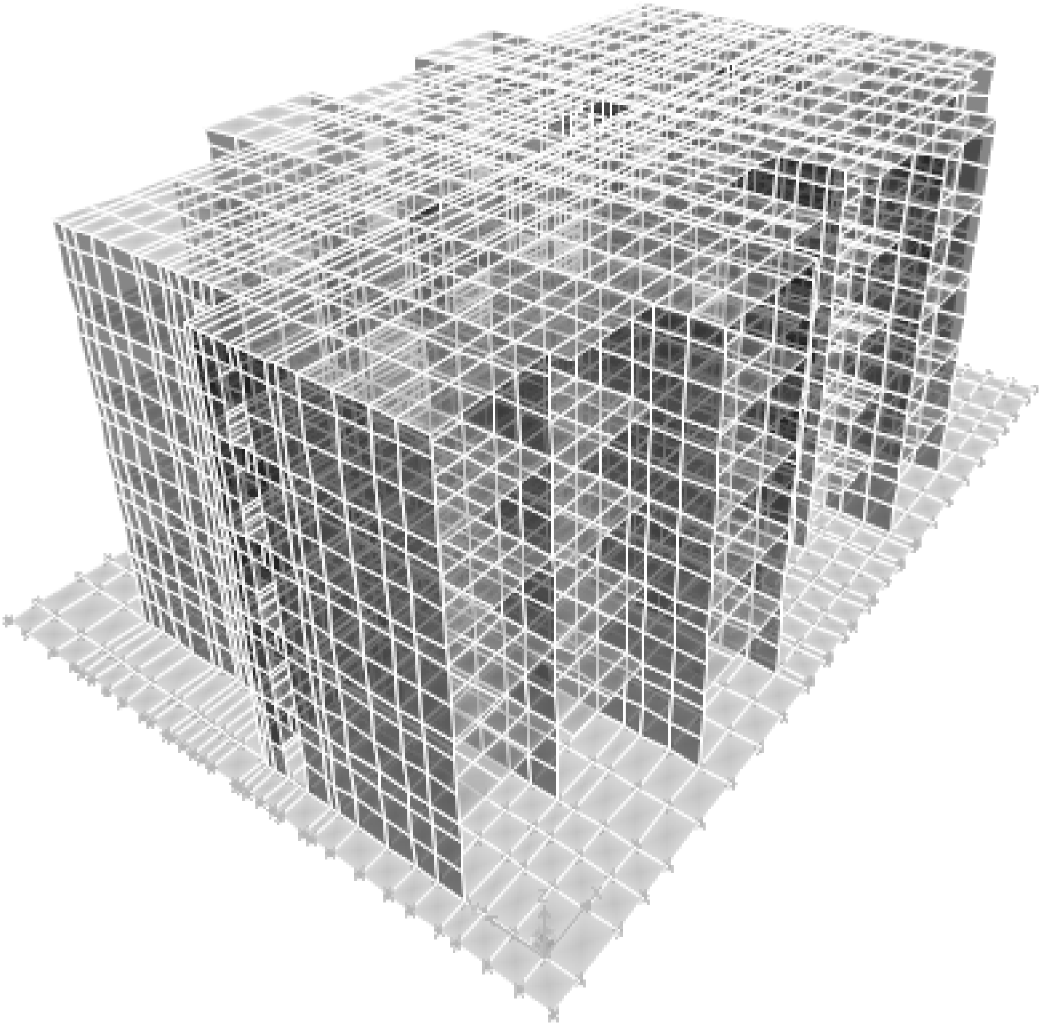

Figure 3.3 Typical three-dimensional mesh modeling for five-shear-wall dominant building (Plan No. 2)

The material properties used in the dynamic analysis of the models are presented in Table 3.1.

Table 3.1 Material properties of concrete

E (t/m^2)	u	f_{c28} (t/m^2)
2,14 x 10^6	0,2	1925

3.3. REPRESENTATION OF SOIL EFFECTS ON THE FOUNDATION

Within the framework of this study 140 shear-wall dominant structures having a variety of plans, heights and wall-configurations were analyzed for four different soil conditions classified according to National Earthquake Hazard Reduction Program, NEHRP [11]. NEHRP defines the site classes as follows:

1. Class B (SB): Rock with average shear wave velocity, 2500 ft/sec<$\overline{n_s}$ <5000 ft/sec
2. Class C (SC): Very dense soil and soft rock with 1200 ft/sec<$\overline{n_s}$ <2500 ft/sec or with either standard blow count $\overline{N}$ >50 or undrained shear strength $\overline{s_u}$ >2000 psf
3. Class D (SD): Stiff soil with 600 ft/sec<$\overline{n_s}$ <1200 ft/sec or with 15< $\overline{N}$ <50 or 1000 psf < $\overline{s_u}$ < 2000psf
4. Class E (SE): Any profile with more than 10 feet of soft clay defined as soil with plasticity index *PI* >20; or water content w >40 percent, and $\overline{s_u}$ <500 psf or soil profile with $\overline{n_s}$ < 600 ft/sec.

The soil effects on the foundation were represented by translational (k_c) and rotational (k_θ) springs. To determine the lumped rotational and translational soil-foundation stiffnesses, an approximation made by Ghrib and Mamedov [5] will be followed. The translational and rotational rigidities of springs were evaluated from the foundation size and elastic uniform compressibility of the soil. The lumped rotational stiffness of foundation is defined as follows:

$$k_\theta = 2C_u I_{OF} \tag{2.1}$$

where C_u is the elastic uniform compressibility of the soil which is obtained from the standard Mat-test [14], and I_{OF} is the moment of inertia of the foundation. The lumped translational stiffness of the foundation is defined as follows:

$$k_c = 0.7 C_u A_F \tag{2.2}$$

where A_F is the foundation area in meter^2.

In the calculation of translational and rotational stiffness of the foundation, the following values of elastic uniform compressibility of the soil for four different soil conditions (SB, SC, SD, SE) were used:

Table 3.2 Elastic uniform compressibility of soil

Soil	**Elastic Uniform Compressibility, C_u (kN/m^3)**
SB	90000
SC	70000
SD	40000
SE	20000

Distributed vertical stiffness properties were calculated by dividing the total vertical stiffness by the area of the foundation. On the other hand, uniformly distributed rotational stiffness properties were calculated by dividing the total rotational stiffness of the foundation by the moment of inertia of the foundation in the direction of loading [14].

In foundation spring modeling, it is assumed that there is no coupling of the spring stiffnesses that are specified in the spring stiffness in global directions area of the form [12]. That is, for the spring stiffnesses specified in the spring stiffness in global direction area, the deformation in one degree of freedom does not affect the deformation in another degree of freedom.

CHAPTER 4

ESTIMATION OF FUNDAMENTAL PERIODS WITH AND WITHOUT SOIL-STRUCTURE INTERACTION

4.1. GENERAL

The results of the analyses and the development of the empirical equation complementing this work and previous study conducted by Balkaya and Kalkan (2004) are given in the following paragraphs. With all this available information, this study provides an improved methodology for the estimation of fundamental period based on specific parameters characterizing soil-structure interaction and the structural and architectural properties of the building. Finally, comparison between the proposed formula and empirical equations given in UBC and TSC were given in the following paragraphs.

4.2. RESULTS OF DYNAMIC ANALYSIS

The three-dimensional finite-element dynamic analysis of 140 shear-wall dominant buildings for four different soil conditions was performed by using ETABS [12]. The structural properties (height, shear-wall area & plan and foundation dimensions) and results of the dynamic analysis (periods & first mode shapes) for the fixed case and four different soil conditions are presented in Table 4.1.

Compared with the fixed-base modeling approach the predicted period of the structure lengthens and the first mode shape of the structures may change depending on the different soil conditions as shown in Table 4.1 (Plan9 &20).

In this study, the soil effects on foundation were represented by translational and rotational springs only, so for buildings, that show torsional behavior in their first modes, the change in the fundamental periods are small for different soil conditions, as shown in Table 4.1 (Plan 12&13).

Table 4.1 Structural and dynamic properties of shear-wall dominant buildings

Plan No.	No. of story	Height (m)	Plan Dimension (m)		Shear-wall area (m^2)		Shear-wall area percentage		Foundation Dimension (m)		Period, T(s) - FEM results with respect to soil conditions									
			Length	Width	Length	Width	Length	Width	Length	Width	Fixed	1^{st} mode	SB	1^{st} mode	SC	1^{st} mode	SD	1^{st} mode	SE	1^{st} mode
1	5	14,00	29,70	15,70	4,78	17,80	0,010	0,038	31,70	17,70	0,13	Long.	0,16	Long.	0,16	Long.	0,17	Long.	0,19	Long.
	10	28,00	29,70	15,70	4,78	17,80	0,010	0,038	31,70	17,70	0,29	Long.	0,35	Long.	0,36	Long.	0,37	Long.	0,45	Trans.
	12	33,60	29,70	15,70	4,78	17,80	0,010	0,038	31,70	17,70	0,37	Long.	0,44	Long.	0,44	Long.	0,48	Trans.	0,58	Trans.
	15	42,00	29,70	15,70	4,78	17,80	0,010	0,038	31,70	17,70	0,49	Long.	0,58	Trans.	0,60	Trans.	0,67	Trans.	0,81	Trans.
	18	50,40	29,70	15,70	5,98	22,25	0,013	0,048	31,70	17,70	0,70	Long.	0,76	Trans.	0,79	Trans.	0,89	Trans.	1,09	Trans.
	20	56,00	29,70	15,70	7,97	29,67	0,017	0,064	31,70	17,70	0,74	Long.	0,89	Trans.	0,93	Trans.	1,07	Trans.	1,33	Trans.
	25	70,00	29,70	15,70	7,97	29,67	0,017	0,064	31,70	17,70	1,03	Long.	1,27	Trans.	1,33	Trans.	1,51	Trans.	1,88	Trans.
2	5	14,00	31,04	19,92	3,40	19,92	0,005	0,032	33,04	21,92	0,12	Long.	0,15	Long.	0,15	Long.	0,16	Long.	0,18	Long.
	10	28,00	31,04	19,92	3,40	19,92	0,005	0,032	33,04	21,92	0,28	Long.	0,32	Long.	0,33	Long.	0,35	Long.	0,39	Long.
	12	33,60	31,04	19,92	3,40	19,92	0,005	0,032	33,04	21,92	0,35	Long.	0,40	Long.	0,41	Long.	0,44	Long.	0,50	Long.
	15	42,00	31,04	19,92	3,40	19,92	0,005	0,032	33,04	21,92	0,47	Long.	0,54	Long.	0,55	Long.	0,59	Long.	0,67	Torsion
	18	50,40	31,04	19,92	4,25	24,90	0,007	0,040	33,04	21,92	0,58	Long.	0,67	Torsion	0,69	Torsion	0,75	Torsion	0,87	Torsion
	20	56,00	31,04	19,92	5,67	33,20	0,009	0,054	33,04	21,92	0,64	Long.	0,78	Torsion	0,80	Torsion	0,89	Torsion	1,03	Torsion
	25	70,00	31,04	19,92	5,67	33,20	0,009	0,054	33,04	21,92	0,95	Long.	1,10	Torsion	1,14	Torsion	1,24	Torsion	1,41	Torsion
3	5	14,00	38,80	17,03	3,98	19,60	0,006	0,030	40,80	19,03	0,14	Long.	0,16	Long.	0,17	Long.	0,17	Long.	0,18	Long.
	10	28,00	38,80	17,03	3,98	19,60	0,006	0,030	40,80	19,03	0,31	Long.	0,34	Long.	0,34	Long.	0,36	Long.	0,41	Torsion
	12	33,60	38,80	17,03	3,98	19,60	0,006	0,030	40,80	19,03	0,39	Long.	0,42	Long.	0,42	Long.	0,45	Torsion	0,53	Torsion
	15	42,00	38,80	17,03	3,98	19,60	0,006	0,030	40,80	19,03	0,50	Long.	0,54	Long.	0,55	Torsion	0,61	Torsion	0,73	Torsion
	18	50,40	38,80	17,03	4,98	24,50	0,008	0,037	40,80	19,03	0,59	Long.	0,69	Torsion	0,72	Torsion	0,81	Torsion	0,96	Torsion
	20	56,00	38,80	17,03	6,64	32,67	0,010	0,049	40,80	19,03	0,64	Long.	0,81	Torsion	0,85	Torsion	0,96	Torsion	1,17	Trans.
	25	70,00	38,80	17,03	6,64	32,67	0,010	0,049	40,80	19,03	0,93	Long.	1,16	Torsion	1,21	Torsion	1,34	Torsion	1,66	Trans.
4	5	14,00	12,00	8,00	1,44	2,88	0,015	0,030	14,00	10,00	0,14	Trans.	0,16	Trans.	0,17	Trans.	0,20	Trans.	0,25	Trans.
	10	28,00	12,00	8,00	1,44	2,88	0,015	0,030	14,00	10,00	0,35	Trans.	0,45	Trans.	0,47	Trans.	0,53	Trans.	0,65	Trans.
	12	33,60	12,00	8,00	1,44	2,88	0,015	0,030	14,00	10,00	0,49	Trans.	0,61	Trans.	0,64	Trans.	0,71	Trans.	0,86	Trans.
	15	42,00	12,00	8,00	1,44	2,88	0,015	0,030	14,00	10,00	0,76	Trans.	0,90	Trans.	0,93	Trans.	1,02	Trans.	1,21	Trans.
	18	50,40	12,00	8,00	1,80	3,60	0,019	0,038	14,00	10,00	1,01	Trans.	1,20	Trans.	1,24	Trans.	1,38	Trans.	1,64	Trans.
	20	56,00	12,00	8,00	2,40	4,80	0,025	0,050	14,00	10,00	1,17	Trans.	1,42	Trans.	1,47	Trans.	1,65	Trans.	2,01	Trans.
	25	70,00	12,00	8,00	2,40	4,80	0,025	0,050	14,00	10,00	1,81	Trans.	2,11	Trans.	2,19	Trans.	2,42	Trans.	2,89	Trans.

Table 4.1 continued

Plan	No. of	Height	Plan Dimension (m)		Shear-wall area (m^2)		Shear-wall area percentage		Foundation Dimension (m)		Period, T(s) - FEM results with respect to soil conditions									
No.	story	(m)	Length	Width	Length	Width	Length	Width	Length	Width	Fixed	1^{st} mode	SB	1^{st} mode	SC	1^{st} mode	SD	1^{st} mode	SE	1^{st} mode
5	5	14,00	12,00	8,00	3,84	1,92	0,040	0,020	14,00	10,00	0,16	Torsion	0,21	Torsion	0,22	Torsion	0,24	Torsion	0,25	Torsion
	10	28,00	12,00	8,00	3,84	1,92	0,040	0,020	14,00	10,00	0,43	Torsion	0,48	Torsion	0,48	Torsion	0,49	Torsion	0,62	Trans.
	12	33,60	12,00	8,00	3,84	1,92	0,040	0,020	14,00	10,00	0,55	Torsion	0,59	Torsion	0,60	Torsion	0,63	Trans.	0,81	Trans.
	15	42,00	12,00	8,00	3,84	1,92	0,040	0,020	14,00	10,00	0,74	Torsion	0,77	Torsion	0,77	Torsion	0,89	Trans.	1,13	Trans.
	18	50,40	12,00	8,00	4,80	2,40	0,050	0,025	14,00	10,00	0,89	Torsion	0,96	Trans.	1,03	Trans.	1,21	Trans.	1,57	Trans.
	20	56,00	12,00	8,00	6,40	3,20	0,067	0,033	14,00	10,00	0,97	Torsion	1,17	Trans.	1,26	Trans.	1,51	Trans.	1,97	Trans.
	25	70,00	12,00	8,00	6,40	3,20	0,067	0,033	14,00	10,00	1,28	Torsion	1,71	Trans.	1,82	Trans.	2,16	Trans.	2,79	Trans.
6	5	14,00	12,00	8,00	1,44	3,84	0,015	0,040	14,00	10,00	0,11	Long.	0,15	Trans.	0,16	Trans.	0,19	Trans.	0,24	Trans.
	10	28,00	12,00	8,00	1,44	3,84	0,015	0,040	14,00	10,00	0,32	Long.	0,43	Trans.	0,45	Trans.	0,51	Trans.	0,64	Trans.
	12	33,60	12,00	8,00	1,44	3,84	0,015	0,040	14,00	10,00	0,45	Long.	0,58	Trans.	0,60	Trans.	0,69	Trans.	0,84	Trans.
	15	42,00	12,00	8,00	1,44	3,84	0,015	0,040	14,00	10,00	0,69	Long.	0,84	Trans.	0,88	Trans.	0,98	Trans.	1,20	Trans.
	18	50,40	12,00	8,00	1,80	4,80	0,019	0,050	14,00	10,00	0,93	Long.	1,14	Trans.	1,19	Trans.	1,34	Trans.	1,64	Trans.
	20	56,00	12,00	8,00	2,40	6,40	0,025	0,067	14,00	10,00	1,08	Long.	1,36	Trans.	1,43	Trans.	1,63	Trans.	2,03	Trans.
	25	70,00	12,00	8,00	2,40	6,40	0,025	0,067	14,00	10,00	1,68	Long.	2,02	Trans.	2,11	Trans.	2,38	Trans.	2,91	Trans.
7	5	14,00	12,00	8,00	2,88	2,64	0,030	0,028	14,00	10,00	0,13	Torsion	0,17	Trans.	0,18	Trans.	0,21	Trans.	0,27	Trans.
	10	28,00	12,00	8,00	2,88	2,64	0,030	0,028	14,00	10,00	0,35	Torsion	0,47	Trans.	0,50	Trans.	0,57	Trans.	0,70	Trans.
	12	33,60	12,00	8,00	2,88	2,64	0,030	0,028	14,00	10,00	0,50	Torsion	0,64	Trans.	0,67	Trans.	0,75	Trans.	0,91	Trans.
	15	42,00	12,00	8,00	2,88	2,64	0,030	0,028	14,00	10,00	0,75	Torsion	0,92	Trans.	0,96	Trans.	1,07	Trans.	1,28	Trans.
	18	50,40	12,00	8,00	3,60	3,30	0,038	0,034	14,00	10,00	1,02	Torsion	1,24	Trans.	1,29	Trans.	1,45	Trans.	1,75	Trans.
	20	56,00	12,00	8,00	4,80	4,40	0,050	0,046	14,00	10,00	1,18	Torsion	1,49	Trans.	1,55	Trans.	1,76	Trans.	2,16	Trans.
	25	70,00	12,00	8,00	4,80	4,40	0,050	0,046	14,00	10,00	1,83	Torsion	2,20	Trans.	2,28	Trans.	2,55	Trans.	3,09	Trans.
8	5	14,00	38,80	17,03	3,98	19,60	0,006	0,030	40,80	19,03	0,14	Torsion	0,20	Torsion	0,21	Torsion	0,23	Torsion	0,26	Torsion
	10	28,00	38,80	17,03	3,98	19,60	0,006	0,030	40,80	19,03	0,44	Torsion	0,51	Torsion	0,52	Torsion	0,54	Torsion	0,67	Trans.
	12	33,60	38,80	17,03	3,98	19,60	0,006	0,030	40,80	19,03	0,58	Torsion	0,65	Torsion	0,66	Torsion	0,71	Trans.	0,89	Trans.
	15	42,00	38,80	17,03	3,98	19,60	0,006	0,030	40,80	19,03	0,82	Torsion	0,89	Torsion	0,90	Trans.	1,02	Trans.	1,25	Trans.
	18	50,40	38,80	17,03	4,98	24,50	0,008	0,037	40,80	19,03	1,03	Torsion	1,17	Trans.	1,23	Trans.	1,40	Trans.	1,72	Trans.
	20	56,00	38,80	17,03	6,64	32,67	0,010	0,049	40,80	19,03	1,15	Torsion	1,41	Trans.	1,49	Trans.	1,71	Trans.	2,15	Trans.
	25	70,00	38,80	17,03	6,64	32,67	0,010	0,049	40,80	19,03	1,69	Torsion	2,09	Trans.	2,19	Trans.	2,49	Trans.	3,07	Trans.

Table 4.1 continued

Plan	No. of	Height	Plan Dimension (m)		Shear-wall area (m^2)		Shear-wall area percentage		Foundation Dimension (m)		Period, T(s) - FEM results with respect to soil conditions									
No.	story	(m)	Length	Width	Length	Width	Length	Width	Length	Width	Fixed	1st mode	SB	1st mode	SC	1st mode	SD	1st mode	SE	1st mode
9	5	14,00	12,00	8,00	4,80	1,92	0,050	0,020	14,00	10,00	0,16	Torsion	0,22	Torsion	0,22	Torsion	0,24	Torsion	0,25	Torsion
	10	28,00	12,00	8,00	4,80	1,92	0,050	0,020	14,00	10,00	0,43	Torsion	0,48	Torsion	0,48	Torsion	0,50	Trans.	0,64	Trans.
	12	33,60	12,00	8,00	4,80	1,92	0,050	0,020	14,00	10,00	0,55	Torsion	0,59	Torsion	0,59	Torsion	0,65	Trans.	0,84	Trans.
	15	42,00	12,00	8,00	4,80	1,92	0,050	0,020	14,00	10,00	0,74	Torsion	0,77	Torsion	0,78	Trans.	0,92	Trans.	1,18	Trans.
	18	50,40	12,00	8,00	6,00	2,40	0,063	0,025	14,00	10,00	0,89	Torsion	1,00	Trans.	1,07	Trans.	1,27	Trans.	1,64	Trans.
	20	56,00	12,00	8,00	8,00	3,20	0,083	0,033	14,00	10,00	0,98	Torsion	1,23	Trans.	1,32	Trans.	1,58	Trans.	2,08	Trans.
	25	70,00	12,00	8,00	8,00	3,20	0,083	0,033	14,00	10,00	1,28	Torsion	1,79	Trans.	1,91	Trans.	2,27	Trans.	2,94	Trans.
10	5	14,00	35,00	20,00	7,20	12,96	0,010	0,019	37,00	22,00	0,16	Long.	0,18	Long.	0,19	Long.	0,19	Long.	0,20	Long.
	10	28,00	35,00	20,00	7,20	12,96	0,010	0,019	37,00	22,00	0,38	Long.	0,41	Long.	0,41	Long.	0,42	Long.	0,44	Long.
	12	33,60	35,00	20,00	7,20	12,96	0,010	0,019	37,00	22,00	0,48	Long.	0,51	Long.	0,51	Long.	0,53	Long.	0,56	Torsion
	15	42,00	35,00	20,00	7,20	12,96	0,010	0,019	37,00	22,00	0,64	Long.	0,67	Long.	0,67	Long.	0,69	Long.	0,76	Torsion
	18	50,40	35,00	20,00	9,00	16,20	0,013	0,023	37,00	22,00	0,80	Long.	0,84	Long.	0,85	Long.	0,87	Long.	0,99	Torsion
	20	56,00	35,00	20,00	12,00	21,60	0,017	0,031	37,00	22,00	0,92	Long.	0,97	Long.	0,98	Long.	1,02	Long.	1,17	Torsion
	25	70,00	35,00	20,00	12,00	21,60	0,017	0,031	37,00	22,00	1,22	Long.	1,28	Long.	1,30	Long.	1,40	Torsion	1,61	Torsion
11	5	14,00	11,00	9,00	2,64	1,80	0,027	0,018	13,00	11,00	0,23	Torsion	0,28	Torsion	0,29	Torsion	0,31	Torsion	0,34	Torsion
	10	28,00	11,00	9,00	2,64	1,80	0,027	0,018	13,00	11,00	0,63	Torsion	0,68	Torsion	0,68	Torsion	0,70	Torsion	0,72	Torsion
	12	33,60	11,00	9,00	2,64	1,80	0,027	0,018	13,00	11,00	0,82	Torsion	0,86	Torsion	0,87	Torsion	0,88	Torsion	0,90	Trans.
	15	42,00	11,00	9,00	2,64	1,80	0,027	0,018	13,00	11,00	0,83	Torsion	1,16	Torsion	1,16	Torsion	1,17	Torsion	1,18	Trans.
	18	50,40	11,00	9,00	3,30	2,25	0,033	0,023	13,00	11,00	1,35	Torsion	1,38	Torsion	1,38	Torsion	1,39	Torsion	1,52	Trans.
	20	56,00	11,00	9,00	4,40	3,00	0,044	0,030	13,00	11,00	1,44	Torsion	1,48	Torsion	1,48	Torsion	1,55	Trans.	1,82	Trans.
	25	70,00	11,00	9,00	4,40	3,00	0,044	0,030	13,00	11,00	1,94	Torsion	2,02	Trans.	2,07	Trans.	2,25	Trans.	2,61	Trans.
12	5	14,00	31,50	27,15	9,70	13,86	0,011	0,016	33,50	29,15	0,16	Torsion	0,21	Torsion	0,22	Torsion	0,24	Torsion	0,27	Torsion
	10	28,00	31,50	27,15	9,70	13,86	0,011	0,016	33,50	29,15	0,42	Torsion	0,49	Torsion	0,51	Torsion	0,54	Torsion	0,59	Torsion
	12	33,60	31,50	27,15	9,70	13,86	0,011	0,016	33,50	29,15	0,55	Torsion	0,63	Torsion	0,64	Torsion	0,68	Torsion	0,73	Torsion
	15	42,00	31,50	27,15	9,70	13,86	0,011	0,016	33,50	29,15	0,77	Torsion	0,85	Torsion	0,87	Torsion	0,90	Torsion	0,96	Torsion
	18	50,40	31,50	27,15	12,13	17,33	0,014	0,020	33,50	29,15	0,98	Torsion	1,06	Torsion	1,08	Torsion	1,12	Torsion	1,19	Torsion
	20	56,00	31,50	27,15	16,17	23,10	0,019	0,027	33,50	29,15	1,10	Torsion	1,20	Torsion	1,22	Torsion	1,27	Torsion	1,36	Torsion
	25	70,00	31,50	27,15	16,17	23,10	0,019	0,027	33,50	29,15	1,54	Torsion	1,64	Torsion	1,66	Torsion	1,72	Torsion	1,80	Torsion

Table 4.1 continued

Plan	No. of	Height	Plan Dimension (m)		Shear-wall area (m^2)		Shear-wall area percentage		Foundation Dimension (m)		Period, T(s) - FEM results with respect to soil conditions									
No.	story	(m)	Length	Width	Length	Width	Length	Width	Length	Width	Fixed	1^{st} mode	SB	1^{st} mode	SC	1^{st} mode	SD	1^{st} mode	SE	1^{st} mode
13	5	14,00	25,50	25,04	10,70	10,88	0,017	0,017	27,50	27,04	0,14	Torsion	0,20	Torsion	0,21	Torsion	0,24	Torsion	0,29	Torsion
	10	28,00	25,50	25,04	10,70	10,88	0,017	0,017	27,50	27,04	0,40	Torsion	0,52	Torsion	0,54	Torsion	0,59	Torsion	0,68	Torsion
	12	33,60	25,50	25,04	10,70	10,88	0,017	0,017	27,50	27,04	0,55	Torsion	0,67	Torsion	0,70	Torsion	0,76	Torsion	0,85	Torsion
	15	42,00	25,50	25,04	10,70	10,88	0,017	0,017	27,50	27,04	0,80	Torsion	0,93	Torsion	0,96	Torsion	1,01	Torsion	1,09	Torsion
	18	50,40	25,50	25,04	13,38	13,60	0,021	0,021	27,50	27,04	1,03	Torsion	1,18	Torsion	1,21	Torsion	1,26	Torsion	1,33	Torsion
	20	56,00	25,50	25,04	17,83	18,13	0,028	0,028	27,50	27,04	1,17	Torsion	1,35	Torsion	1,38	Torsion	1,44	Torsion	1,51	Torsion
	25	70,00	25,50	25,04	17,83	18,13	0,028	0,028	27,50	27,04	1,69	Torsion	1,85	Torsion	1,87	Torsion	1,92	Torsion	1,96	Torsion
14	5	14,00	28,00	12,00	2,88	3,60	0,009	0,011	30,00	14,00	0,13	Long.	0,18	Trans.	0,19	Trans.	0,19	Trans.	0,25	Trans.
	10	28,00	28,00	12,00	2,88	3,60	0,009	0,011	30,00	14,00	0,40	Long.	0,47	Trans.	0,49	Trans.	0,53	Trans.	0,61	Trans.
	12	33,60	28,00	12,00	2,88	3,60	0,009	0,011	30,00	14,00	0,54	Long.	0,63	Trans.	0,64	Trans.	0,69	Trans.	0,79	Trans.
	15	42,00	28,00	12,00	2,88	3,60	0,009	0,011	30,00	14,00	0,79	Long.	0,89	Trans.	0,91	Trans.	0,97	Trans.	1,11	Trans.
	18	50,40	28,00	12,00	3,60	4,50	0,011	0,013	30,00	14,00	1,02	Long.	1,15	Trans.	1,18	Trans.	1,27	Trans.	1,47	Trans.
	20	56,00	28,00	12,00	4,80	6,00	0,014	0,018	30,00	14,00	1,16	Long.	1,33	Trans.	1,37	Trans.	1,50	Trans.	1,76	Trans.
	25	70,00	28,00	12,00	4,80	6,00	0,014	0,018	30,00	14,00	1,70	Long.	1,92	Trans.	1,97	Trans.	2,14	Trans.	2,49	Trans.
15	5	14,00	27,00	24,00	8,40	13,55	0,013	0,021	29,00	26,00	0,17	Torsion	0,24	Torsion	0,25	Torsion	0,27	Torsion	0,32	Torsion
	10	28,00	27,00	24,00	8,40	13,55	0,013	0,021	29,00	26,00	0,49	Torsion	0,59	Torsion	0,60	Torsion	0,65	Torsion	0,71	Torsion
	12	33,60	27,00	24,00	8,40	13,55	0,013	0,021	29,00	26,00	0,65	Torsion	0,75	Torsion	0,77	Torsion	0,82	Torsion	0,88	Torsion
	15	42,00	27,00	24,00	8,40	13,55	0,013	0,021	29,00	26,00	0,92	Torsion	1,02	Torsion	1,04	Torsion	1,08	Torsion	1,14	Torsion
	18	50,40	27,00	24,00	10,50	16,94	0,016	0,026	29,00	26,00	1,16	Torsion	1,28	Torsion	1,30	Torsion	1,34	Torsion	1,38	Torsion
	20	56,00	27,00	24,00	14,00	22,58	0,022	0,035	29,00	26,00	1,32	Torsion	1,46	Torsion	1,48	Torsion	1,52	Torsion	1,57	Torsion
	25	70,00	27,00	24,00	14,00	22,58	0,022	0,035	29,00	26,00	1,84	Torsion	1,98	Torsion	1,99	Torsion	2,02	Torsion	2,05	Torsion
16	5	14,00	32,00	26,00	9,40	15,00	0,011	0,018	34,00	28,00	0,17	Torsion	0,23	Torsion	0,24	Torsion	0,26	Torsion	0,29	Torsion
	10	28,00	32,00	26,00	9,40	15,00	0,011	0,018	34,00	28,00	0,49	Torsion	0,56	Torsion	0,57	Torsion	0,60	Torsion	0,64	Torsion
	12	33,60	32,00	26,00	9,40	15,00	0,011	0,018	34,00	28,00	0,64	Torsion	0,71	Torsion	0,72	Torsion	0,75	Torsion	0,80	Torsion
	15	42,00	32,00	26,00	9,40	15,00	0,011	0,018	34,00	28,00	0,88	Torsion	0,95	Torsion	0,96	Torsion	0,99	Torsion	1,04	Torsion
	18	50,40	32,00	26,00	11,75	18,75	0,014	0,023	34,00	28,00	1,10	Torsion	1,18	Torsion	1,19	Torsion	1,22	Torsion	1,28	Torsion
	20	56,00	32,00	26,00	15,67	25,00	0,019	0,030	34,00	28,00	1,24	Torsion	1,34	Torsion	1,35	Torsion	1,39	Torsion	1,46	Torsion
	25	70,00	32,00	26,00	15,67	25,00	0,019	0,030	34,00	28,00	1,69	Torsion	1,78	Torsion	1,80	Torsion	1,84	Torsion	1,91	Torsion

Table 4.1 continued

Plan No.	No. of story	Height (m)	Plan Dimension (m)		Shear-wall area (m^2)		Shear-wall area percentage		Foundation Dimension (m)		Period, T(s) - FEM results with respect to soil conditions									
			Length	Width	Length	Width	Length	Width	Length	Width	Fixed	1^{st} mode	SB	1^{st} mode	SC	1^{st} mode	SD	1^{st} mode	SE	1^{st} mode
17	5	14,00	24,00	14,00	4,80	7,44	0,014	0,022	26,00	16,00	0,17	Torsion	0,24	Torsion	0,25	Torsion	0,28	Torsion	0,32	Torsion
	10	28,00	24,00	14,00	4,80	7,44	0,014	0,022	26,00	16,00	0,48	Torsion	0,58	Torsion	0,60	Torsion	0,65	Torsion	0,74	Torsion
	12	33,60	24,00	14,00	4,80	7,44	0,014	0,022	26,00	16,00	0,63	Torsion	0,75	Torsion	0,77	Torsion	0,83	Torsion	0,92	Torsion
	15	42,00	24,00	14,00	4,80	7,44	0,014	0,022	26,00	16,00	0,88	Torsion	1,01	Torsion	1,03	Torsion	0,98	Torsion	1,19	Torsion
	18	50,40	24,00	14,00	6,00	9,30	0,018	0,028	26,00	16,00	1,12	Torsion	1,28	Torsion	1,31	Torsion	1,37	Torsion	1,46	Torsion
	20	56,00	24,00	14,00	8,00	12,40	0,024	0,037	26,00	16,00	1,29	Torsion	1,49	Torsion	1,51	Torsion	1,59	Torsion	1,67	Torsion
	25	70,00	24,00	14,00	8,00	12,40	0,024	0,037	26,00	16,00	1,80	Torsion	2,00	Torsion	2,03	Torsion	2,09	Torsion	2,17	Torsion
18	5	14,00	16,00	12,00	3,84	8,16	0,020	0,043	18,00	14,00	0,11	Torsion	0,14	Torsion	0,14	Torsion	0,15	Trans.	0,19	Trans.
	10	28,00	16,00	12,00	3,84	8,16	0,020	0,043	18,00	14,00	0,26	Torsion	0,32	Trans.	0,34	Trans.	0,40	Trans.	0,51	Trans.
	12	33,60	16,00	12,00	3,84	8,16	0,020	0,043	18,00	14,00	0,33	Torsion	0,43	Trans.	0,45	Trans.	0,53	Trans.	0,67	Trans.
	15	42,00	16,00	12,00	3,84	8,16	0,020	0,043	18,00	14,00	0,45	Torsion	0,60	Trans.	0,64	Trans.	0,74	Trans.	0,94	Trans.
	18	50,40	16,00	12,00	4,80	10,20	0,025	0,053	18,00	14,00	0,59	Torsion	0,81	Trans.	0,86	Trans.	1,01	Trans.	1,29	Trans.
	20	56,00	16,00	12,00	6,40	13,60	0,033	0,071	18,00	14,00	0,68	Torsion	0,98	Trans.	1,05	Trans.	1,25	Trans.	1,62	Trans.
	25	70,00	16,00	12,00	6,40	13,60	0,033	0,071	18,00	14,00	1,03	Torsion	1,42	Trans.	1,51	Trans.	1,78	Trans.	2,29	Trans.
19	5	14,00	28,00	12,00	5,76	6,00	0,017	0,018	30,00	14,00	0,13	Torsion	0,18	Trans.	0,19	Trans.	0,21	Trans.	0,25	Trans.
	10	28,00	28,00	12,00	5,76	6,00	0,017	0,018	30,00	14,00	0,40	Torsion	0,47	Trans.	0,49	Trans.	0,53	Trans.	0,61	Trans.
	12	33,60	28,00	12,00	5,76	6,00	0,017	0,018	30,00	14,00	0,54	Torsion	0,63	Trans.	0,64	Trans.	0,69	Trans.	0,79	Trans.
	15	42,00	28,00	12,00	5,76	6,00	0,017	0,018	30,00	14,00	0,79	Torsion	0,88	Trans.	0,91	Trans.	0,97	Trans.	1,11	Trans.
	18	50,40	28,00	12,00	7,20	7,50	0,021	0,022	30,00	14,00	1,02	Torsion	1,15	Trans.	1,18	Trans.	1,27	Trans.	1,47	Trans.
	20	56,00	28,00	12,00	9,60	10,00	0,029	0,030	30,00	14,00	1,16	Torsion	1,33	Trans.	1,37	Trans.	1,50	Trans.	1,76	Trans.
	25	70,00	28,00	12,00	9,60	10,00	0,029	0,030	30,00	14,00	1,70	Torsion	1,92	Trans.	1,97	Trans.	2,14	Trans.	2,49	Trans.
20	5	14,00	16,00	12,00	3,84	5,76	0,020	0,030	18,00	14,00	0,12	Trans.	0,16	Torsion	0,16	Torsion	0,17	Torsion	0,19	Trans.
	10	28,00	16,00	12,00	3,84	5,76	0,020	0,030	18,00	14,00	0,31	Trans.	0,35	Torsion	0,36	Torsion	0,40	Trans.	0,50	Trans.
	12	33,60	16,00	12,00	3,84	5,76	0,020	0,030	18,00	14,00	0,39	Trans.	0,44	Torsion	0,46	Trans.	0,53	Trans.	0,66	Trans.
	15	42,00	16,00	12,00	3,84	5,76	0,020	0,030	18,00	14,00	0,52	Trans.	0,62	Trans.	0,65	Trans.	0,74	Trans.	0,92	Trans.
	18	50,40	16,00	12,00	4,80	7,20	0,025	0,038	18,00	14,00	0,64	Trans.	0,83	Trans.	0,87	Trans.	1,00	Trans.	1,26	Trans.
	20	56,00	16,00	12,00	6,40	9,60	0,033	0,050	18,00	14,00	0,73	Trans.	0,99	Trans.	1,05	Trans.	1,22	Trans.	1,56	Trans.
	25	70,00	16,00	12,00	6,40	9,60	0,033	0,050	18,00	14,00	1,06	Trans.	1,44	Trans.	1,52	Trans.	1,75	Trans.	2,21	Trans.

Long. implies longitudinal direction, Trans. implies transverse direction.

4.3. ESTIMATION OF FUNDAMENTAL PERIOD WITHOUT SOIL-STRUCTURE INTERACTION

It is a customary practice to obtain the lower bound fundamental period of a structure via code-given expressions to establish the proper design force level unless modal analysis based on the detailed finite element model is conducted [1]. For that reason, accurate estimation of the fundamental period is inevitably essential to calculate the reliable design forces. It has long been observed that when equations given in codes for the estimation of fundamental period are used for shear-wall dominant structures, significant errors tend to occur, especially in the calculation of earthquake loads.

Balkaya and Kalkan (2004) have developed an effective yet simple formula to estimate the fundamental period of shear-wall dominant buildings. The developed equation to predict fundamental period has the following form:

$$T = Ch\frac{\sqrt{R}}{\left(R^{a}{}_{length} + R^{a}{}_{width}\right)} \tag{4.1}$$

where T is the period in second; h is the total height of the building in meter; R is the ratio of long side dimension to short side dimension of the building; R_{length} is the ratio of shear-wall area oriented along the length to a typical story area; and R_{width} is the ratio of shear-wall area oriented along the width to typical story area. In this equation, C and a are the estimator parameters obtained from regression analysis, and are equal to 0.138 and -0.4, respectively. The standard deviation of residuals, s_T, expressing the random variability of periods, is 0.3 and the value of R^2 (i.e., indication of goodness of fit) is equal to 0.80 [1]. Since tunnel form buildings are significantly susceptible to torsion due to the plan shear-wall configuration that is restricted by the tunnel form construction technique, an additional parameter R is plugged into Eq.4.1 incorporating two other new parameters, R_{width} and R_{length} to account for the torsional behavior the effects of shear-walls into the period estimation. Estimated fundamental periods by Eq.4.1 are given in Table B.1.

4.4. ESTIMATION OF FUNDAMENTAL PERIOD WITH SOIL-STRUCTURE INTERACTION

In building codes, to keep the empirical formula simple, only the structural system is taken into account with no specification regarding the soil characteristics on which the building is expected to be built [5]. Although soil-structure interaction has a great impact on the fundamental period of the shear wall dominant buildings, it is not considered in its preliminary design. The fixed-base modeling approach is inappropriate for many structures. Structural systems that incorporate stiff vertical elements for lateral resistance (e.g., shear walls, braced frames) can be particularly sensitive to even small base rotations and translations that are neglected with a fixed base assumption [15].

In this study, previously developed predictive equation is modified to include the impacts of soil-structure interaction on the fundamental period. As a result, an improved empirical formula is proposed from nonlinear regression analysis with the dynamic analysis results. The use of non-linear regression analysis provides a more sophisticated and direct approach to address the uncertainties than do traditional linear analysis procedures [6]. These uncertainties may be induced due to the performed evaluation procedures and tools. The non-linear regression procedure on the database was performed using SPSS [16] statistical analysis software (Ver.10.01, 1999). The new improved formula to predict fundamental periods of shear wall dominant structures has the following form:

$$T = Ch^{D} \frac{\sqrt{R}}{\left(R^{a}{}_{length} + R^{a}{}_{width}\right)} C_{u}{}^{E} R_{F}{}^{F} \qquad (4.2)$$

where *T* is the period in second; *h* is the total height of the building in meter; *R* is the ratio of long side dimension to short side dimension of the building; R_{length} is the ratio of shear-wall area oriented along the length to a typical story area; and R_{width} is the ratio of shear-wall area oriented along the width to typical story area; C_u is the elastic uniform compressibility of the soil in kN/m^3; R_F is the ratio of moment of inertia of foundation in strong axes to weak axes ($R_F \geq 1$). In this equation, *C, D, a, E* and *F* are the estimator parameters obtained from nonlinear regression analysis, and their values are expressed in Table 4.2. The standard deviation of residuals, s_T, expressing the random variability of periods, is 0.241 and the value of R^2 (i.e., indication of goodness of fit) is equal to 0.839.

Table 4.2 Estimator parameters

Case*	**Estimator parameters, All plans**						
	C	*D*	*a*	*E*	*F*	R^2	s_T
A	0,138	1,000	-0,400	0,000	0,000	0,800	0,300
B	0,010	1,471	-0,005	-0,020	-0,325	0,839	0,241

**Case A*: Foundation effect and soil-structure interaction are kept out of modeling (previous study)

Case B: Both foundation effect and soil-structure interaction (SSI) are included in the modeling.

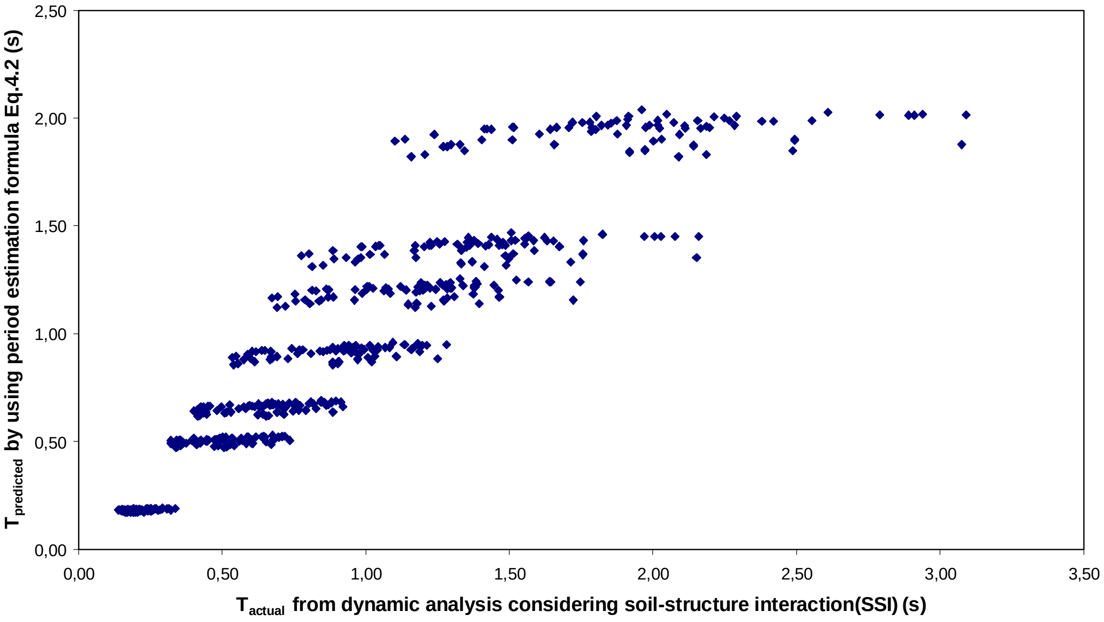

Figure 4.1 Distribution of predicted fundamental periods by Eq.4.2 versus actual periods obtained from dynamic analysis considering soil-structure interaction

In order to represent the effects of soil-structure interaction on the fundamental period of shear wall dominant buildings, two new parameters, C_u and R_F, are introduced to the previously developed formula, since these parameters are directly related to the flexibility of base and the strength of the foundation. Estimated fundamental periods of buildings by Eq.4.2 are given in Table B.1. In Figure 4.2, the distribution of predicted fundamental periods versus actual fundamental periods, obtained for four different soil conditions, are drawn to show how the proposed equation fit the database.

The new proposed equation is capable of modeling both the structural and geotechnical components of the foundation. As a result, the response of the overall structural system includes deformations in structural and geotechnical parts of the foundation system [15]. Proposed equation for estimating the fundamental periods should accurately represent the structural response. As expected, the fundamental periods of structural systems obtained from fixed-base assumption should be shorter than that of obtained from flexible-base assumption. Therefore, the ratio of periods obtained from Eq.4.2 to periods obtained from fixed-base assumption has to be greater than 1. This is illustrated in Figure 4.2 to represent the validity of the proposed equation. As shown in Figure 4.2, in only 15 out of 560 cases, the ratio of periods obtained from Eq.4.2 to periods obtained from fixed base assumption has dropped under 1.

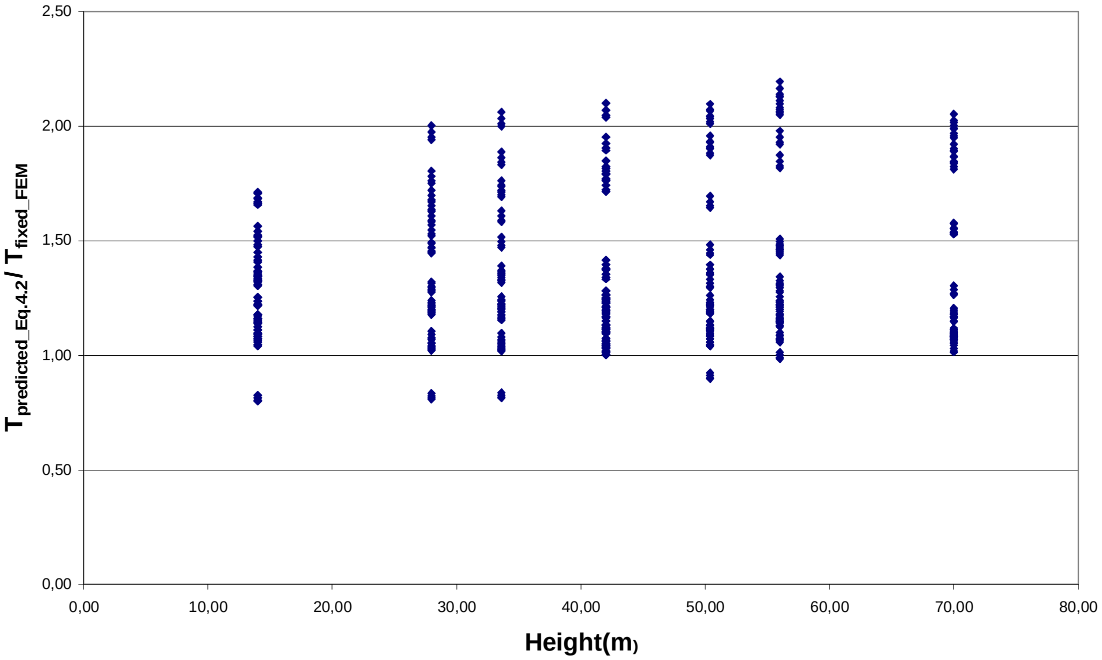

Figure 4.2 Ratio of periods obtained from Eq.4.2 to periods obtained from fixed base assumption

4.5. COMPARISON WITH CURRENT CODE EQUATIONS

In this part, the estimate equation developed in this thesis was compared with those equations given by UBC (1997) and Turkish Seismic Code (1998) and also compared with finite-element analysis results obtained for four different soil conditions. These comparisons are illustrated for various selective cases from Figures 4.3 to 4.5 for plan numbers 7, 12, 14, 17, 19. In these figures, FEM_SB, FEM_SC, FEM_SD and FEM_SE represent the fundamental periods of buildings obtained from the finite element analysis of the buildings for four different soil conditions classified according to NEHRP [11], whereas FEM_FIXED represents the fundamental period of buildings obtained from fixed-base assumption.

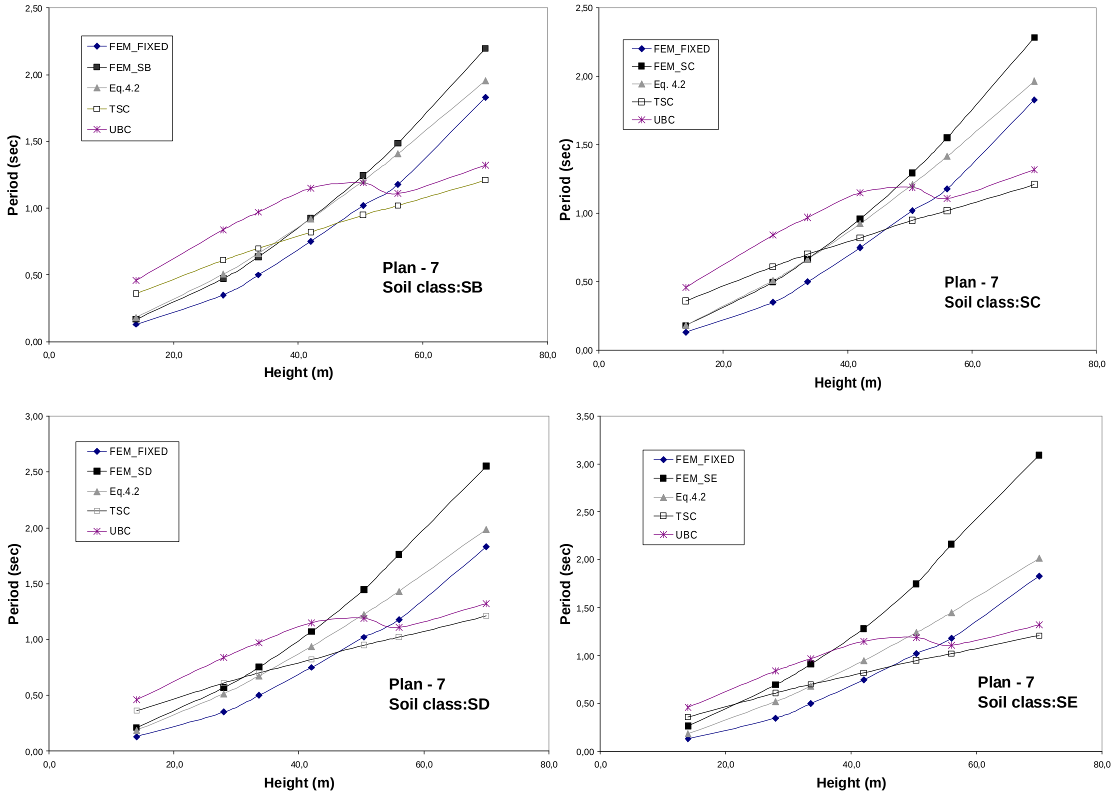

Figure 4.3 Comparison of predicted periods via Eq.4.2 with FEM_FIXED, FEM_SB, FEM_SC, FEM_SD, FEM_SE, UBC (1997) and TSC (1998) (Plan-7)

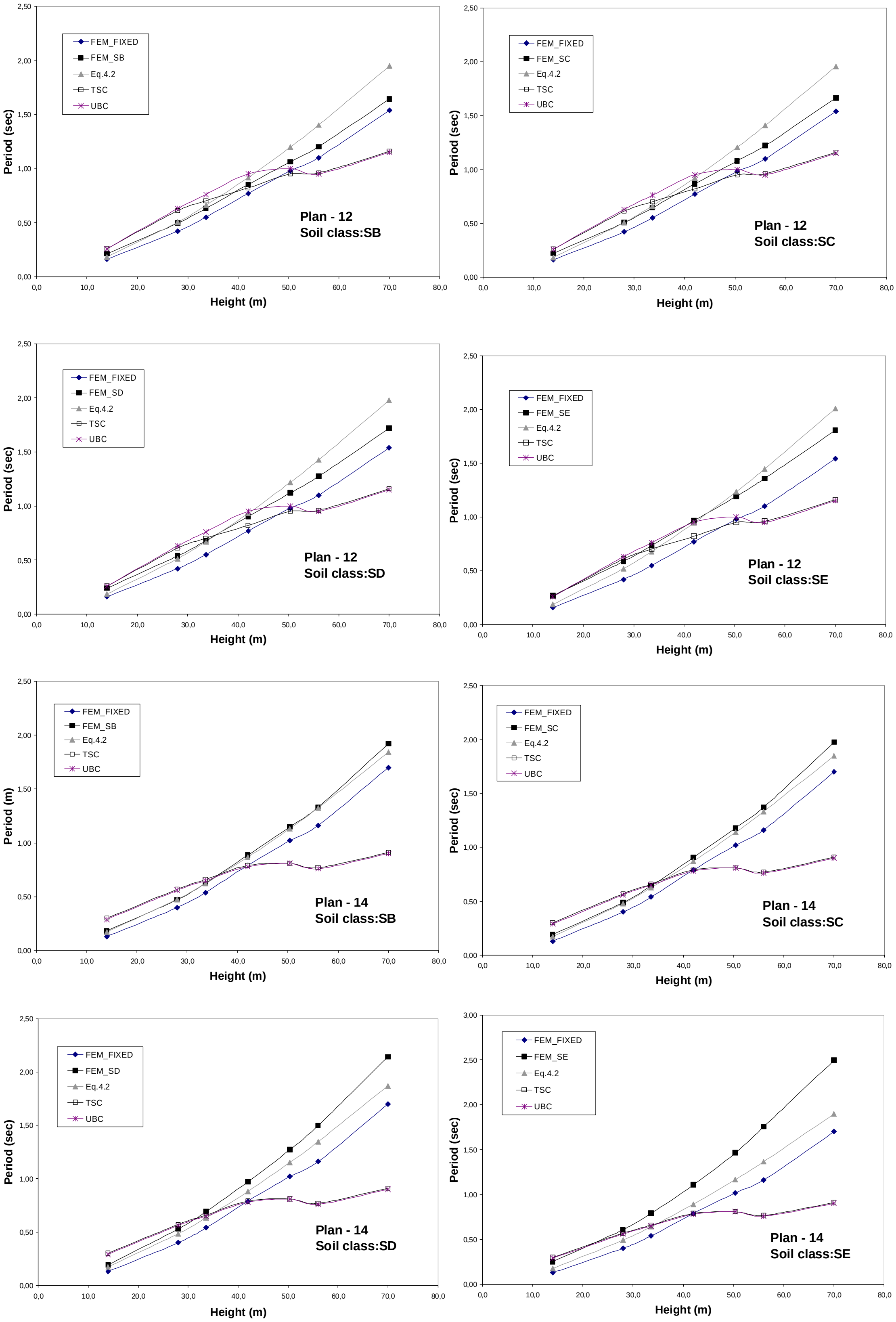

Figure 4.4 Comparison of predicted periods via Eq.4.2 with FEM_FIXED, FEM_SB, FEM_SC, FEM_SD, FEM_SE, UBC (1997) and TSC (1998) (Plan-12 & 14)

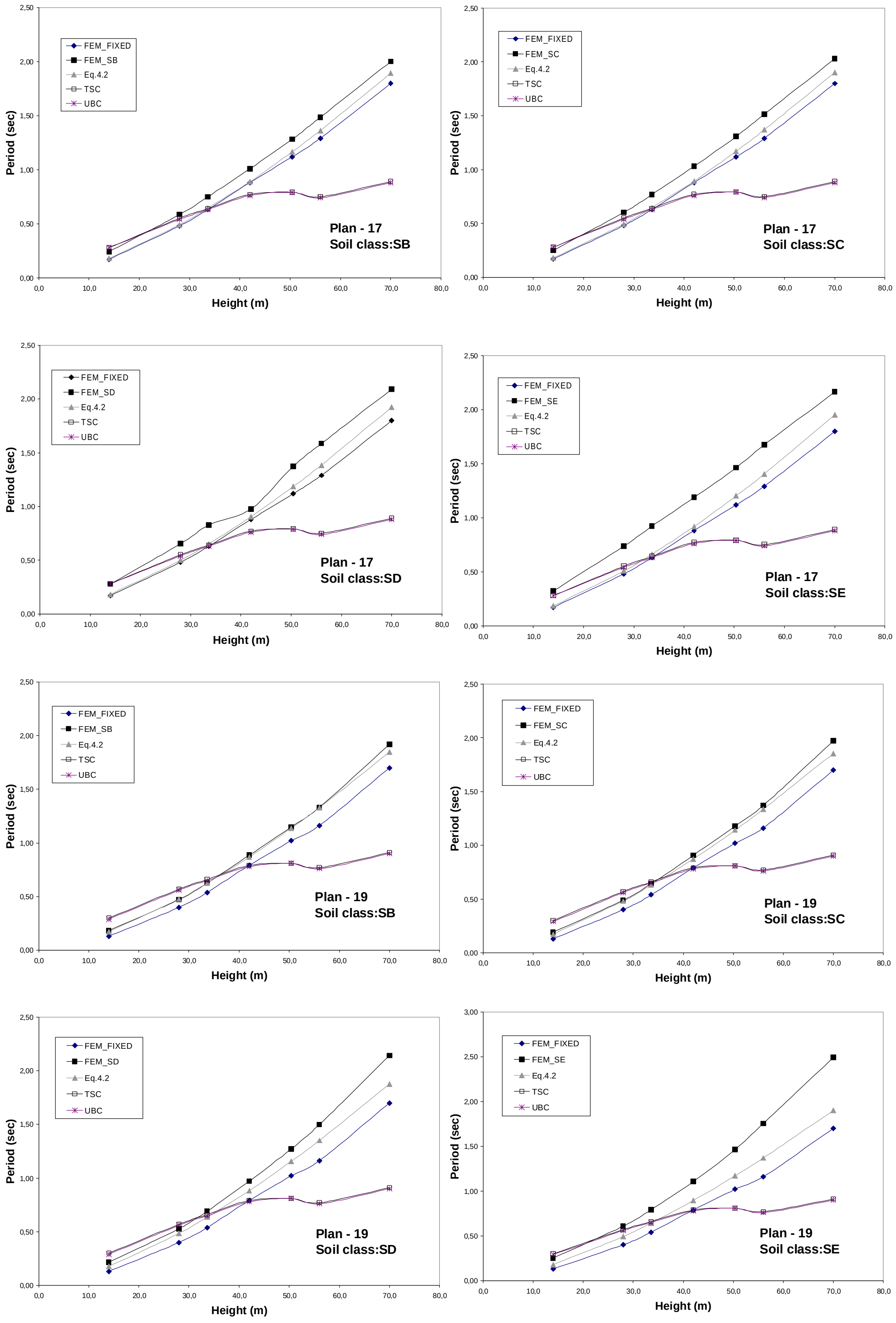

Figure 4.5 Comparison of predicted periods via Eq.4.2 with FEM_FIXED, FEM_SB, FEM_SC, FEM_SD, FEM_SE, UBC (1997) and TSC (1998) (Plan-17 & 19)

Comparisons show significant deviation between the FEM results and those computed using code equations. For many cases, the code equations give a period much longer than those computed for low- and mid-rise (i.e., 5, 10 and 12 story) buildings, whereas for high-rise buildings (i.e., stories ≥ 15) the reverse is observed, and they underestimate the computed periods. In fact, for high-rise buildings the estimated periods in the seismic codes should be the same or less than the actual period of the buildings.

As expected, the fundamental periods of structures built on softer geological sites are longer than those built on rock. This phenomenon is ignored in code formulas and this leads to poor predictions in obtaining the fundamental periods of shear wall dominant systems.

The significant deviation between current code formulas and finite-element analysis leads to intolerable errors for dynamic parameters and corresponding design loads. Generally, performing linear or non-linear detailed three-dimensional finite-element analysis for this structural type is difficult due to the existence of dominant shear-wall configurations [6]. For that reason, an effective yet simple formula is represented in this study by including the soil-structure interaction for practical applications.

In general, comparisons show that there is a good correlation between the estimated periods via Eq.4.2 and finite element results obtained for four different soil conditions. The error in predictions on average is about 15 percent, and lending further credibility to the new proposed formula to be used in engineering practice.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

In current seismic code provisions, estimation of earthquake forces generally by using the design spectra depends on either the use empirical equations for the determination of the fundamental period of a structure or more detailed dynamic analysis. Although soil-structure interaction has a great effect on the fundamental period of the buildings, in order to keep the empirical formula simple in the codes, only structural system is taken into account with no specifications regarding on the soil characteristics on which the building is to be built. In this study, the consistency of empirical equations in the current code provisions related to dynamic properties of shear-wall dominant buildings constructed by using tunnel form techniques are investigated by including soil-structure interaction. Based on the 3-D dynamic analysis of 140 shear-wall dominant buildings, it is confirmed in this study that code formulas for estimating the period are inadequate. Possible sources of discrepancy between the dynamic analysis results and the code estimation can be related to the ignorance of torsional disturbance, soil-structure interaction, foundation and 3-D (T/C coupling) effects as parameters in the code formulas.

Torsional behavior of these structures is an important criterion that should be taken into account in the design since most of the buildings show torsional behavior under their natural vibration modes as shown in Table 4.1. This phenomenon results in the tunnel form construction restrictions, since part of the outside walls should be opened in order to take the formwork back after casting process. For that reason, these buildings have low torsional rigidity. Selection of appropriate side dimensions and symmetrical configuration of shear-walls may help to minimize torsion.

It is also observed from the dynamic analysis of these buildings that different soil conditions have minor effects on buildings having torsion in their first natural vibration mode. This result may arise from the assumptions made in the representation of soil conditions since the soil effects on the foundation were represented by the translational and rotational springs only. Although tunnel form buildings show torsional behavior in their natural vibration modes, empirical formulas given in current seismic codes for estimating the fundamental period of buildings always ignore torsional disturbance of these buildings. The ignorance of torsional behavior of buildings in their first fundamental period may result in erroneous computation of earthquake design forces since the fundamental periods obtained from the empirical equations given in seismic codes are directly used in the calculation of seismic forces and these forces are applied to the buildings in longitudinal or transverse direction.

In most of the seismic code provisions, a common assumption in designing a new building for earthquake resistance is to consider the foundation rigid. The effect of soil-structure interaction on the fundamental period is always underestimated in the empirical equations. The results of the dynamic analysis of buildings for different soil conditions reported in this study demonstrate the effect of the foundation stiffness on the vibration properties of shear-wall dominant buildings. As it is expected from the results that the fundamental periods of shear-wall dominant buildings built on softer geological sites are longer than those built on rock. Additionally, the first mode shape of the buildings may change depending on the different soil conditions as shown in Table 4.1.

Comparisons show significant deviation between the FEM results and those computed using code equations. For many cases, the code equations give a period much longer than those computed for low- and mid-rise (i.e., 5, 10 and 12 story) buildings, whereas for high-rise buildings (i.e., stories ≥ 15) the reverse is observed, and they underestimate the computed periods. In fact, for high-rise buildings the estimated periods in the seismic codes should be the same or less than the actual period of the buildings.

In general, performing linear or nonlinear detailed 3-D finite element analysis on shear-wall dominant buildings is difficult due to the existence of dominant shear-wall configurations [1]. For that reason, the code empirical formulas are generally used to estimate the lower-bound fundamental period. Experimental and analytical studies have collectively indicated that empirical equations in the seismic codes may lead to intolerable errors in estimating the periods of the shear-wall dominant buildings and consequently result in erroneous computation of seismic forces. In order to show the effects of soil-structure interaction on the fundamental periods of shear-wall dominant buildings, an improved formula is proposed in this dissertation for buildings having stories 5-25 with various architectural configurations. The error in the predictions on average is about 15 percent, and lending further credibility to modified formula to be used in engineering practice.

Shear wall dominant buildings provide better seismic performance in addition to their low construction cost compared to conventional RC buildings. For that reason, in this study it was intended to bring the well performance of the shear wall dominant buildings and recommend a new empirical equation to reflect the effects of soil structure interaction on the fundamental periods of these structures for the purpose of revising seismic code provisions since fundamental period of a building is one of the main parameters in the calculation of earthquake forces acting on the structure. Therefore, accurate estimation of fundamental periods of buildings is inevitably essential to obtain reliable earthquake forces.

It should be noted that the proposed equation in this study, which to date are empirical in nature, are based on a consensus of engineering applications. The derived equation in this thesis can be modified and improved by the addition of new data from the 3-D finite element analysis of different tunnel form building configurations and also by the accumulation of new data from the experimental studies considering the soil-structure interaction.

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APPENDICES

A. TYPICAL PLAN VIEWS OF THE BUILDINGS

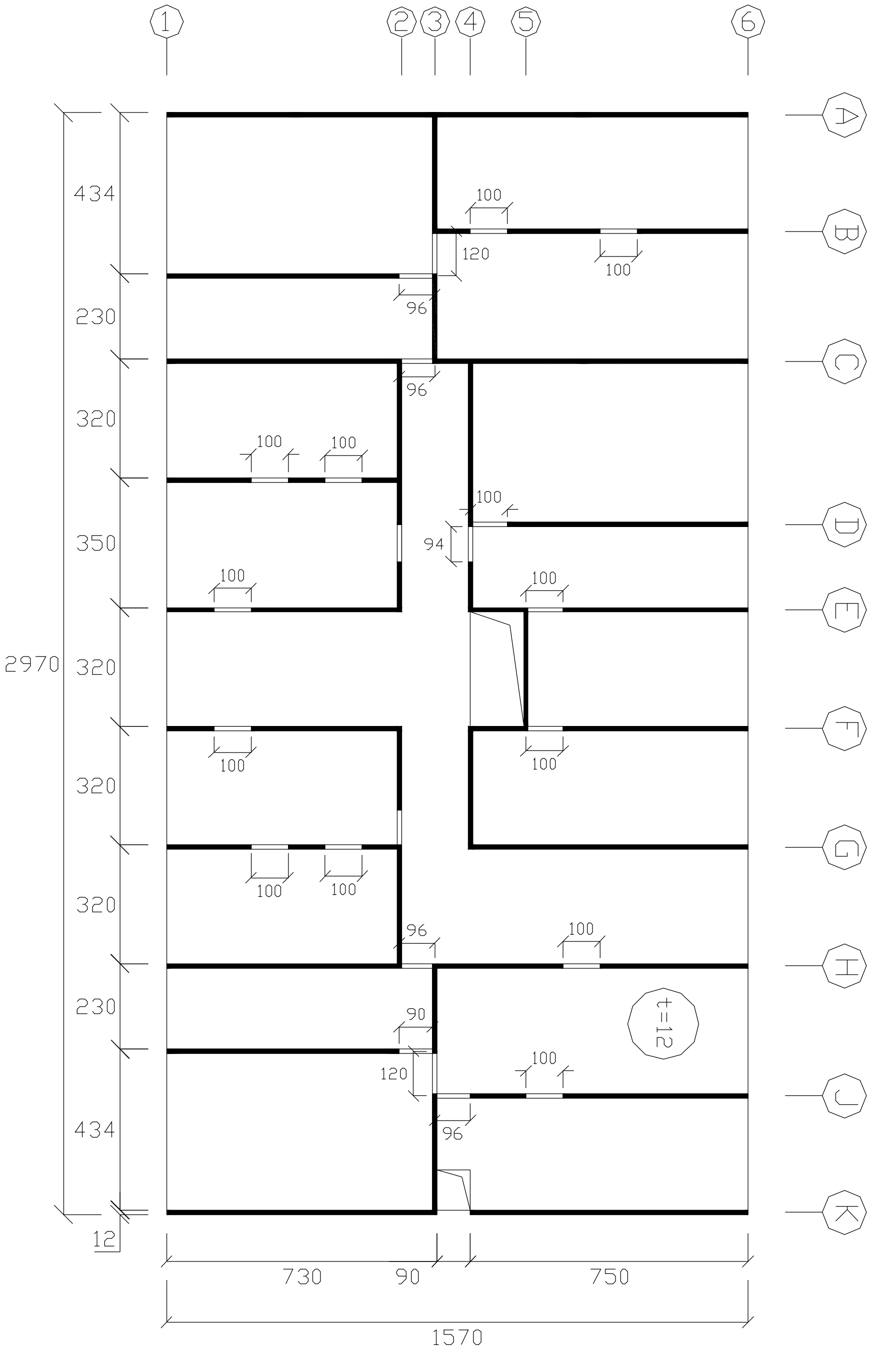

Figure A.1 Typical plan view – Plan No. 1 (units in cm)

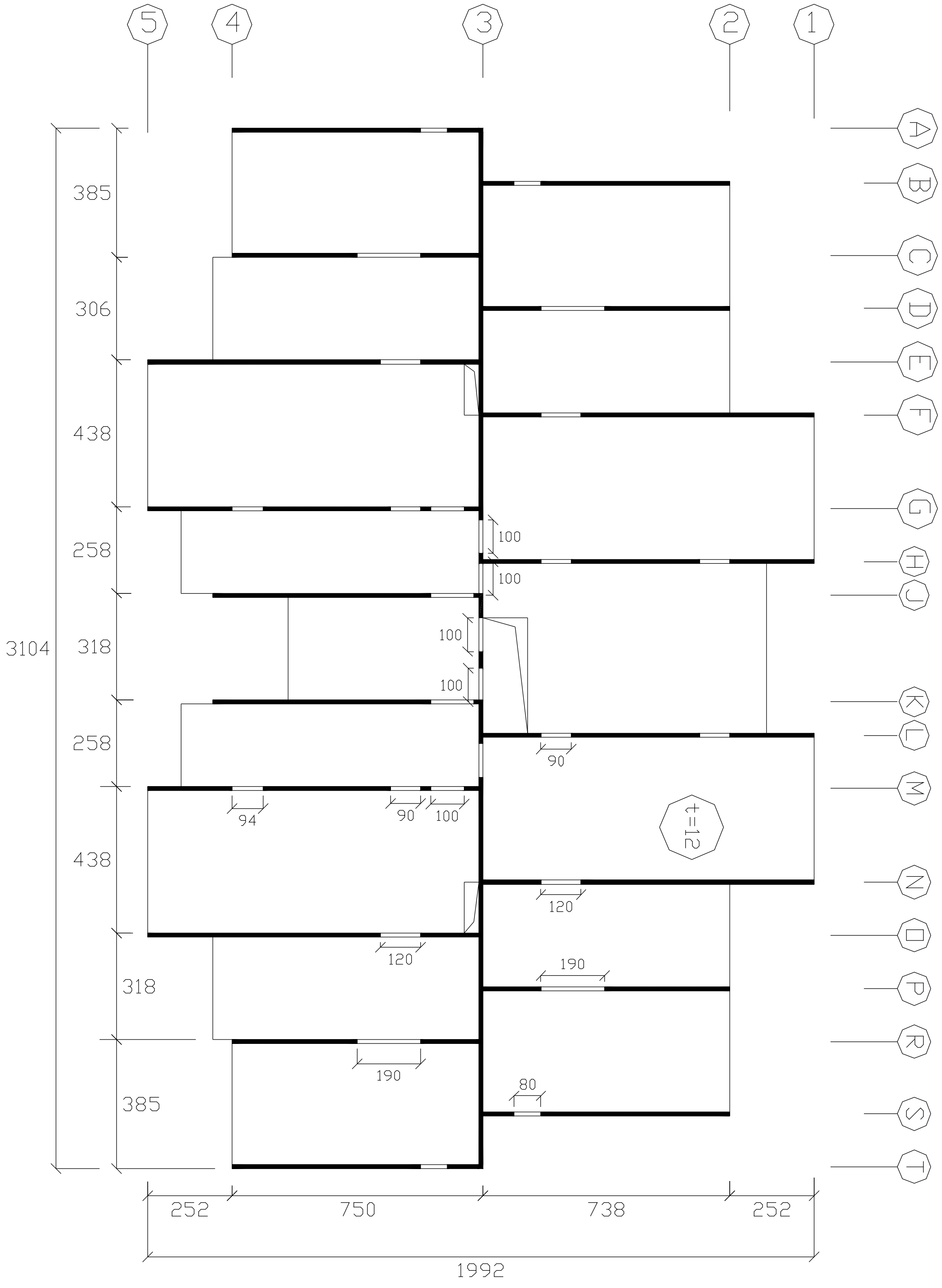

Figure A.2 Typical plan view – Plan No. 2 (units in cm)

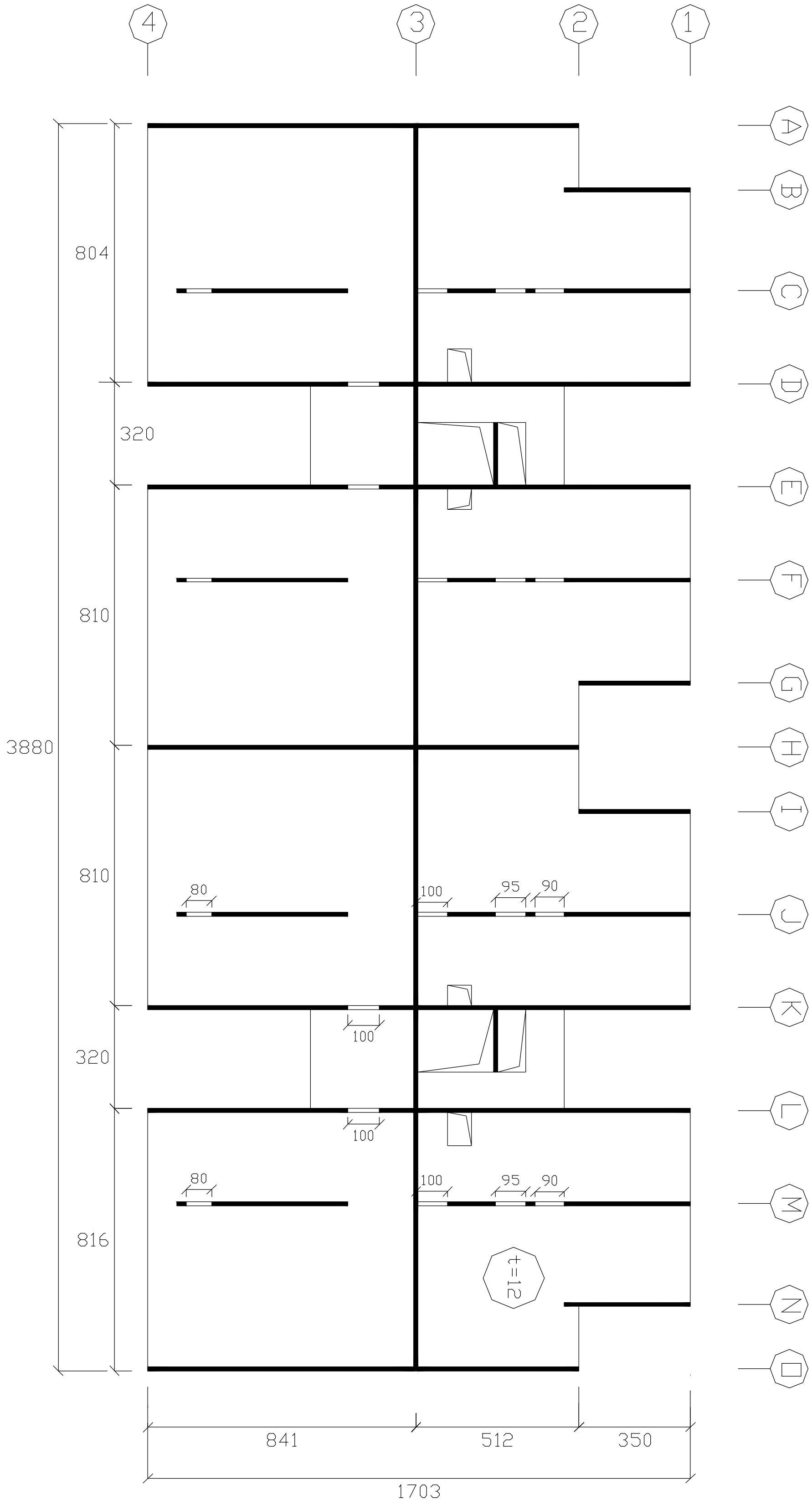

Figure A.3 Typical plan view – Plan No. 3 (units in cm)

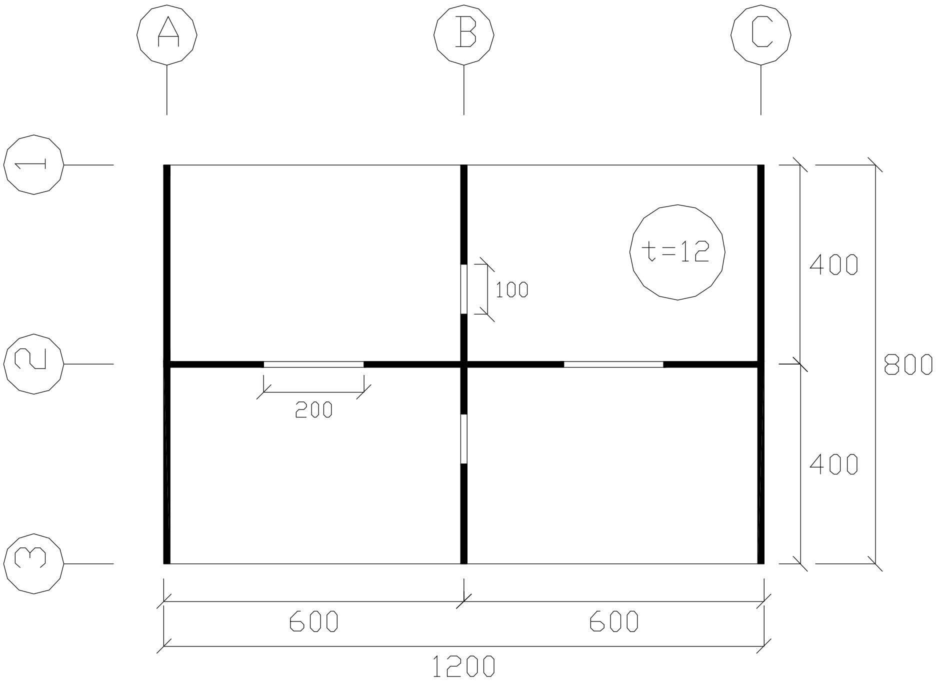

Figure A.4 Typical plan view – Plan No. 4 (units in cm)

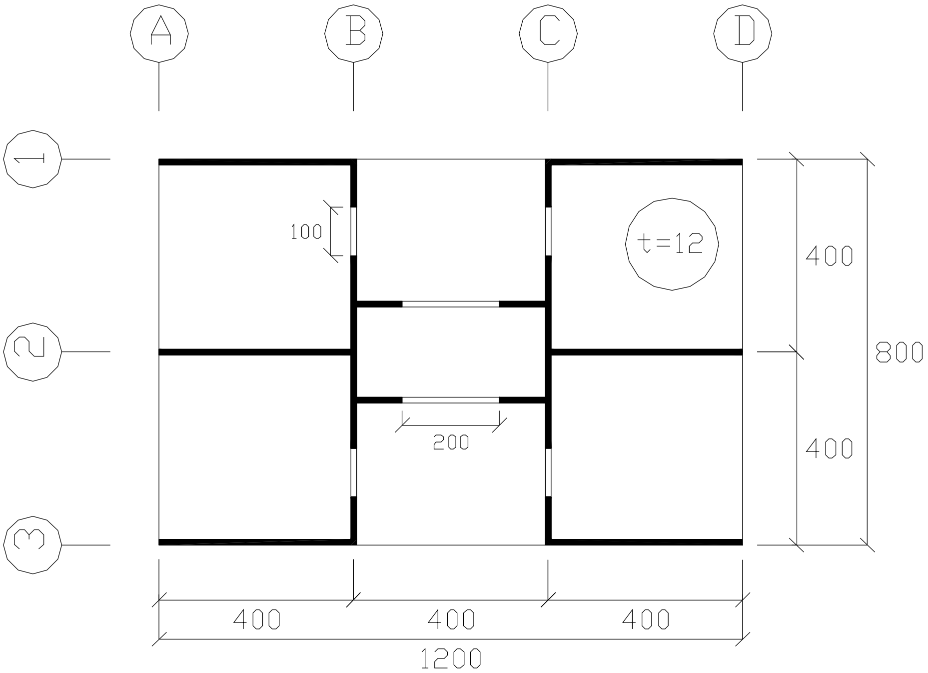

Figure A.5 Typical plan view – Plan No. 5 (units in cm)

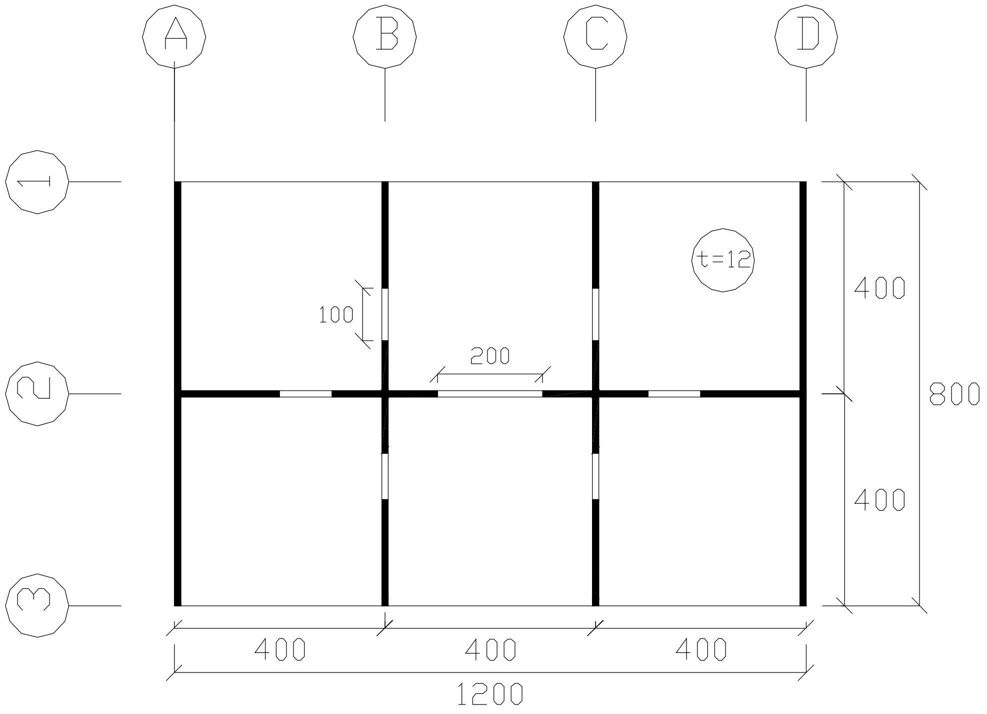

Figure A.6 Typical plan view – Plan No. 6 (units in cm)

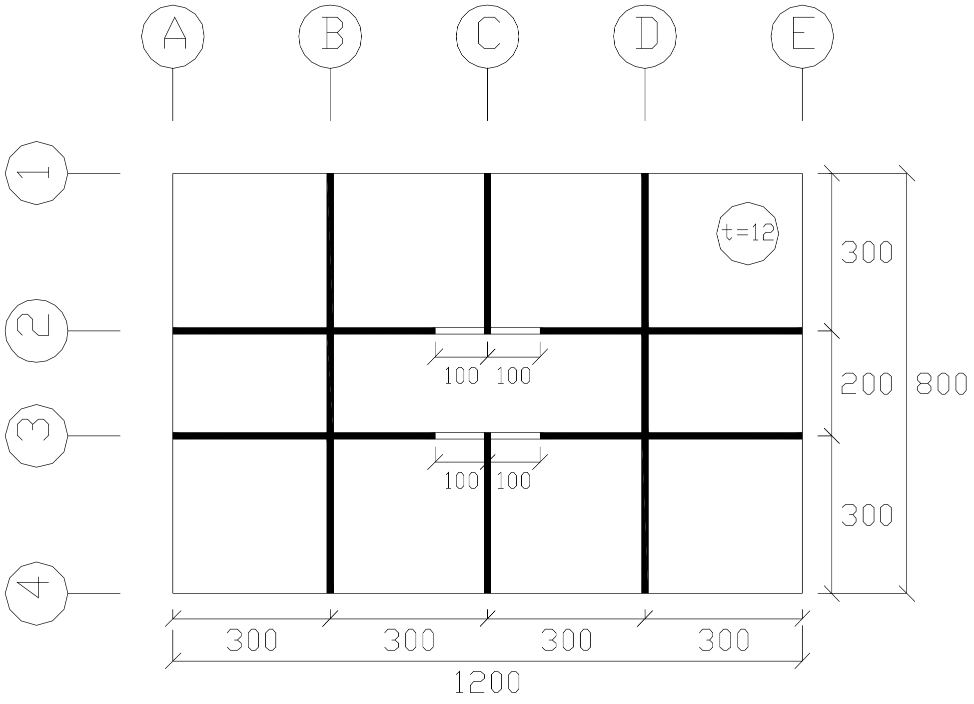

Figure A.7 Typical plan view – Plan No. 7 (units in cm)

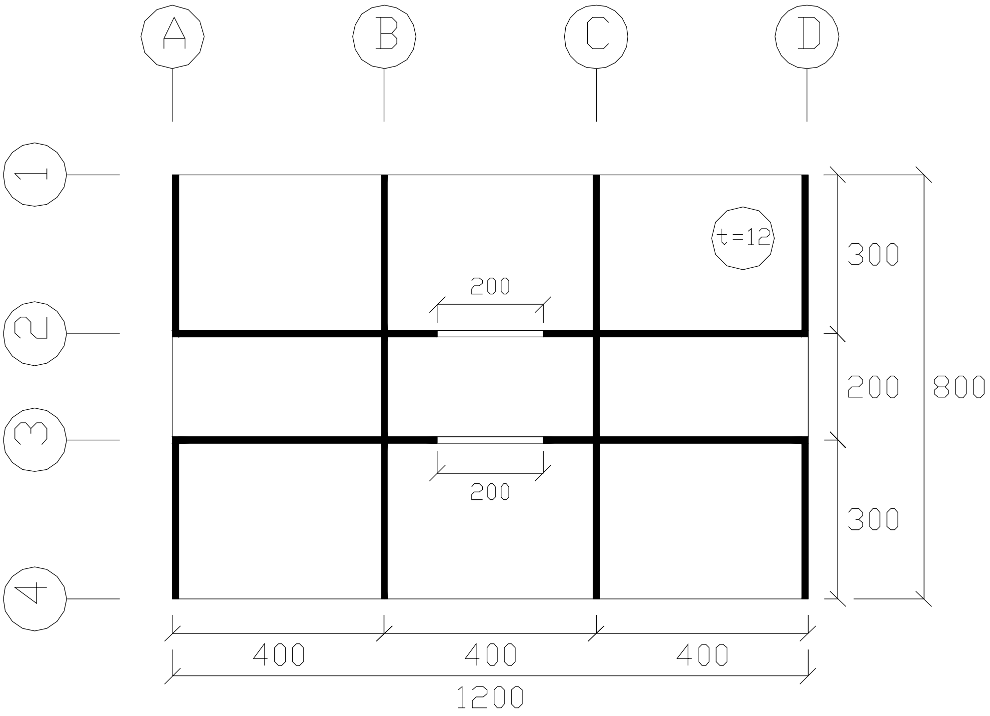

Figure A.8 Typical plan view – Plan No. 8 (units in cm)

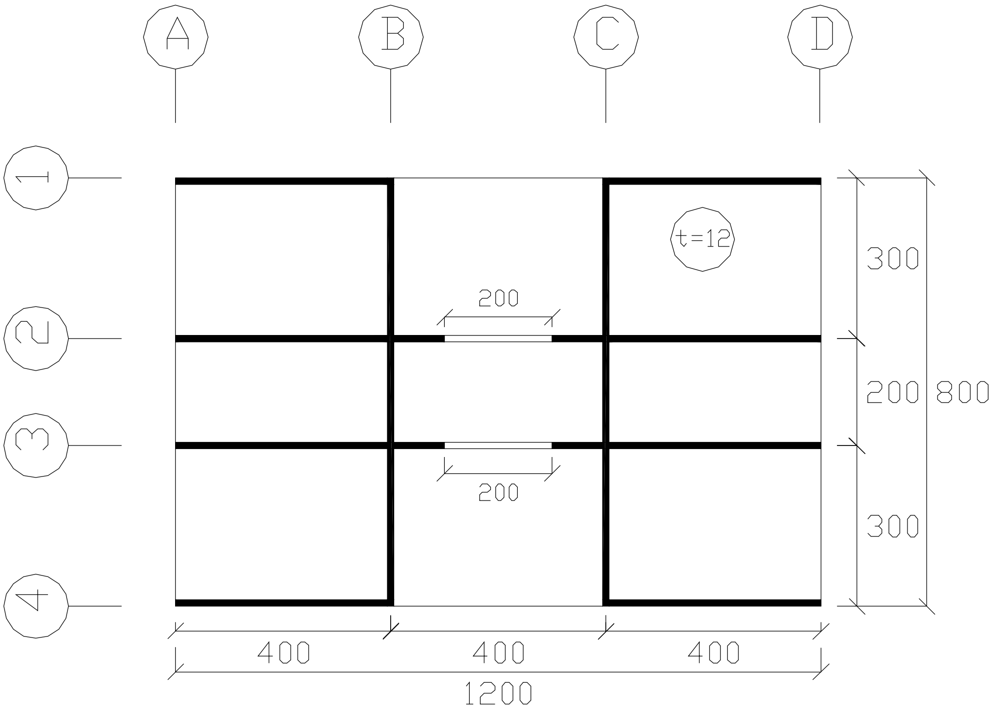

Figure A.9 Typical plan view – Plan No. 9 (units in cm)

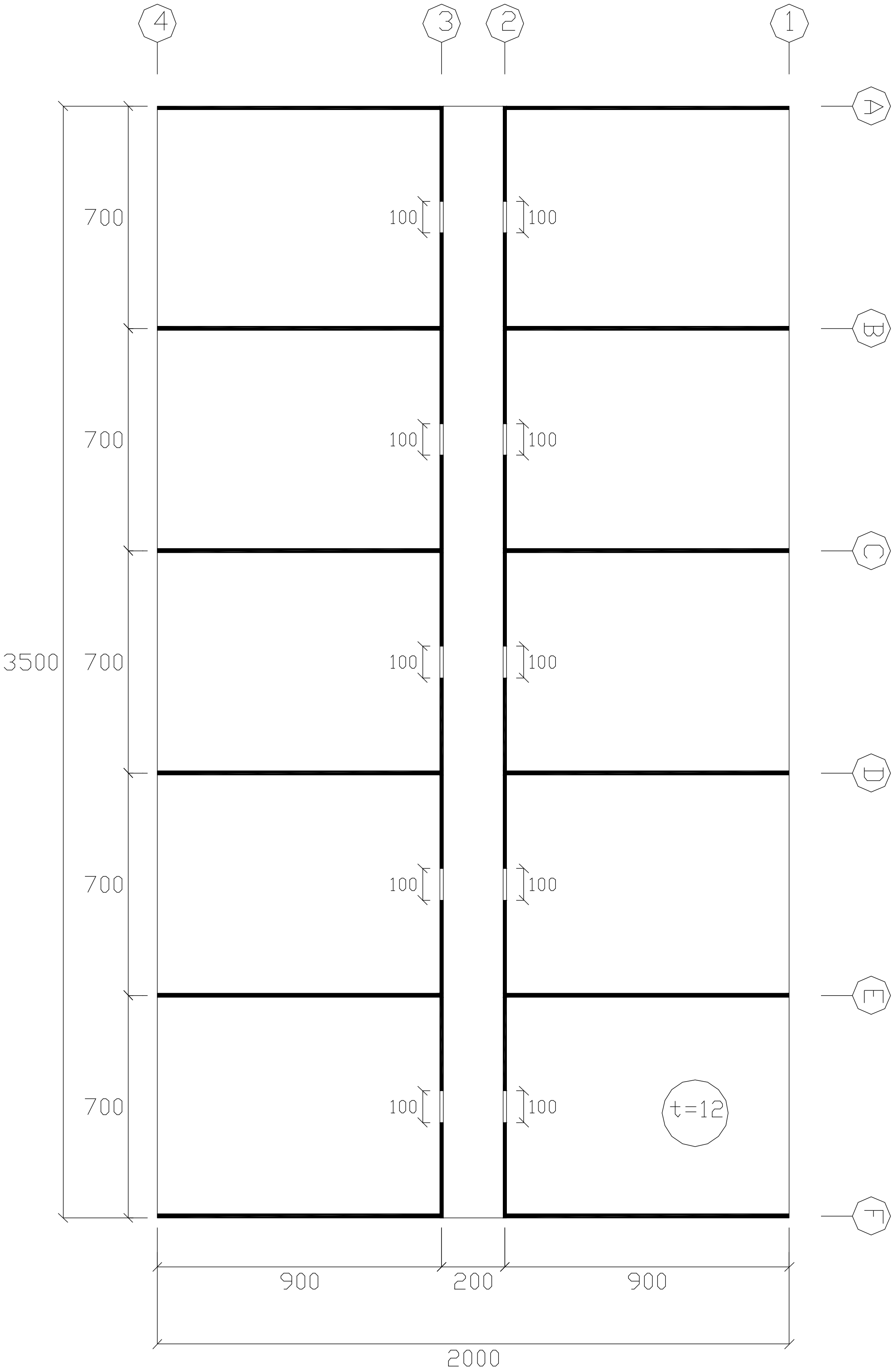

Figure A.10 Typical plan view – Plan No. 10 (units in cm)

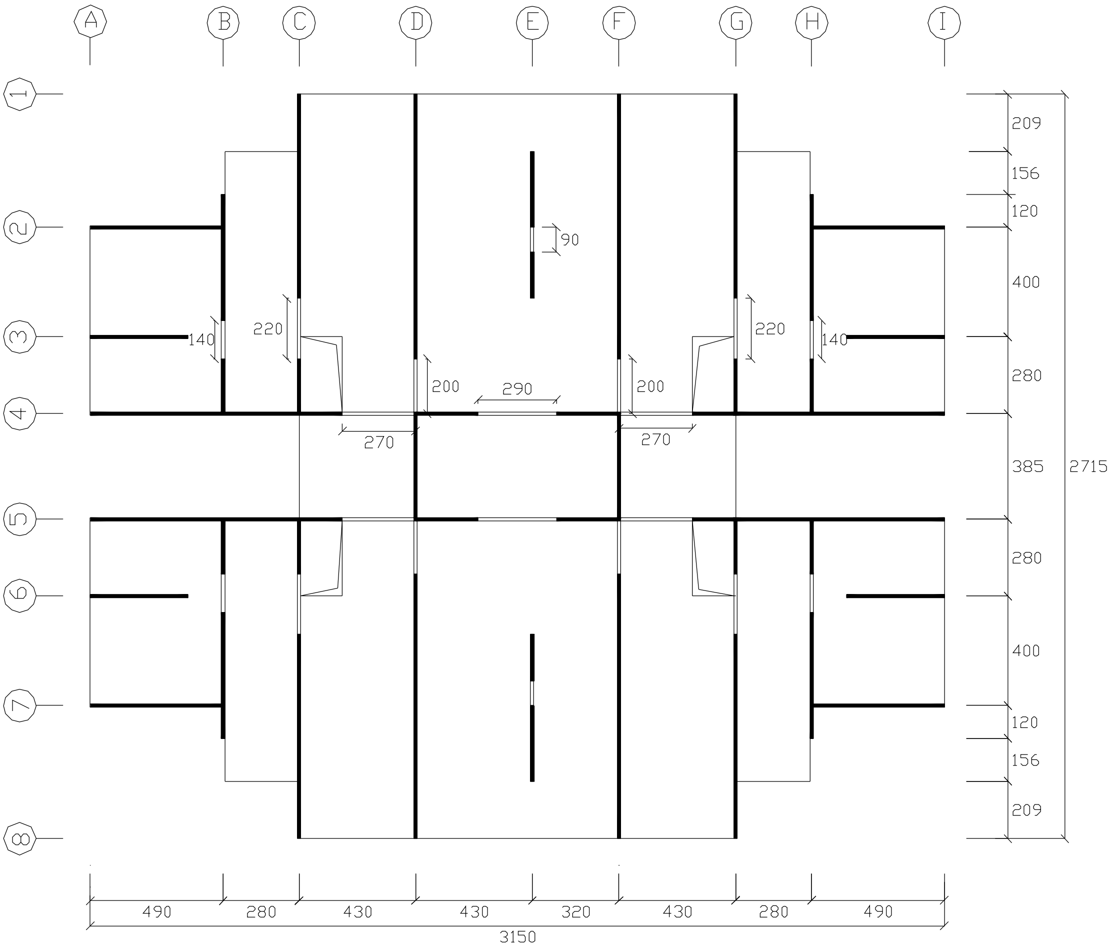

Figure A.11 Typical plan view – Plan No. 12 (units in cm)

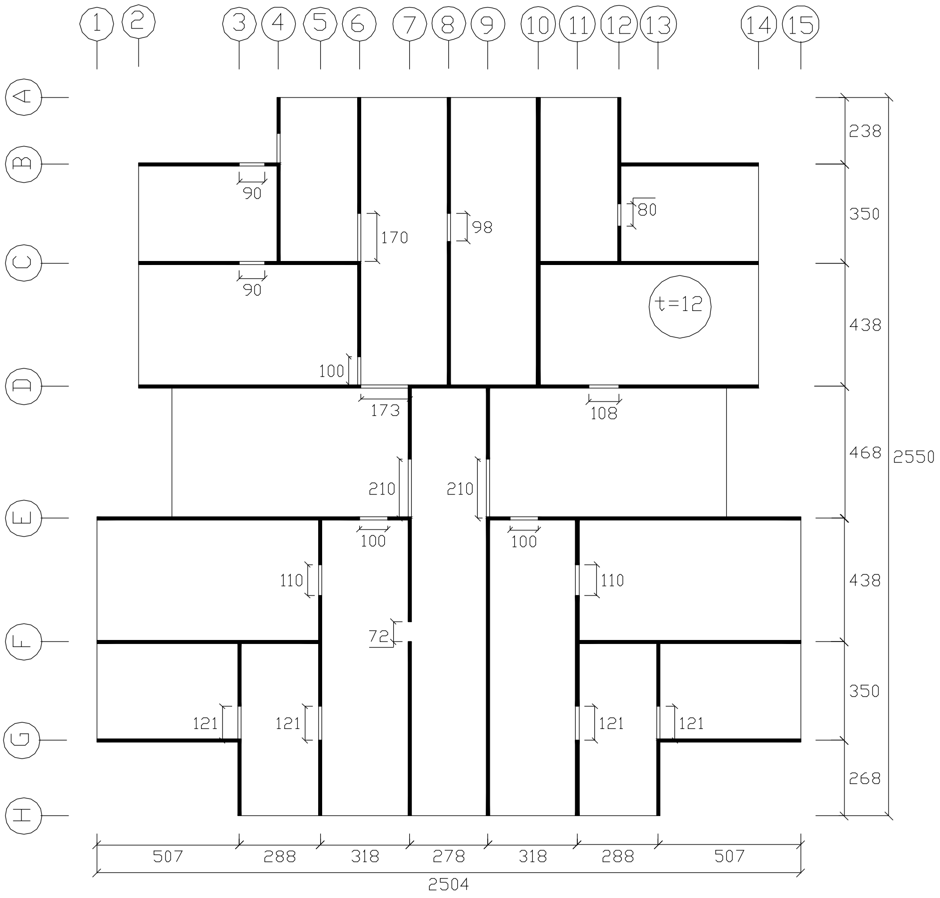

Figure A.12 Typical plan view – Plan No. 13 (units in cm)

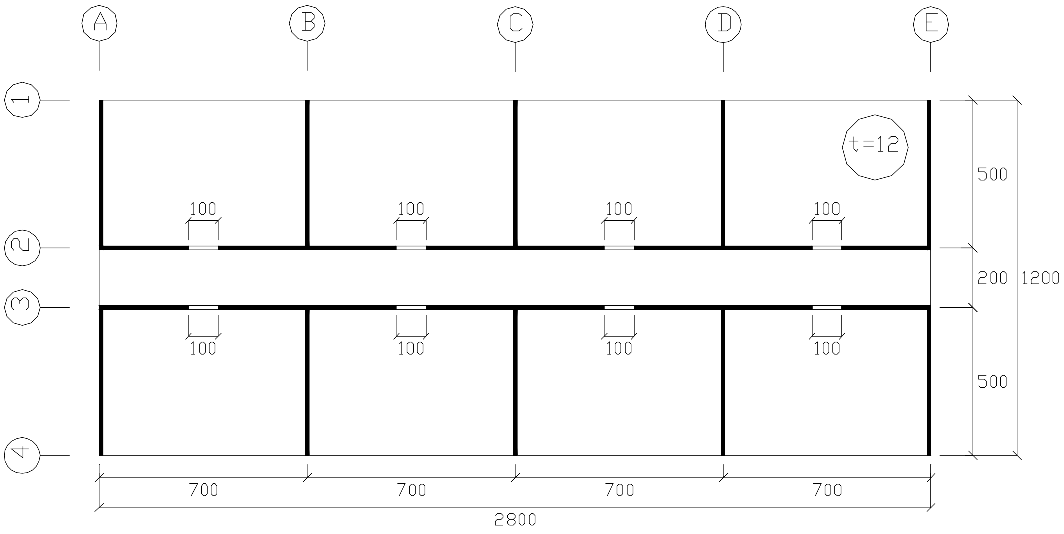

Figure A.13 Typical plan view – Plan No. 14 (units in cm)

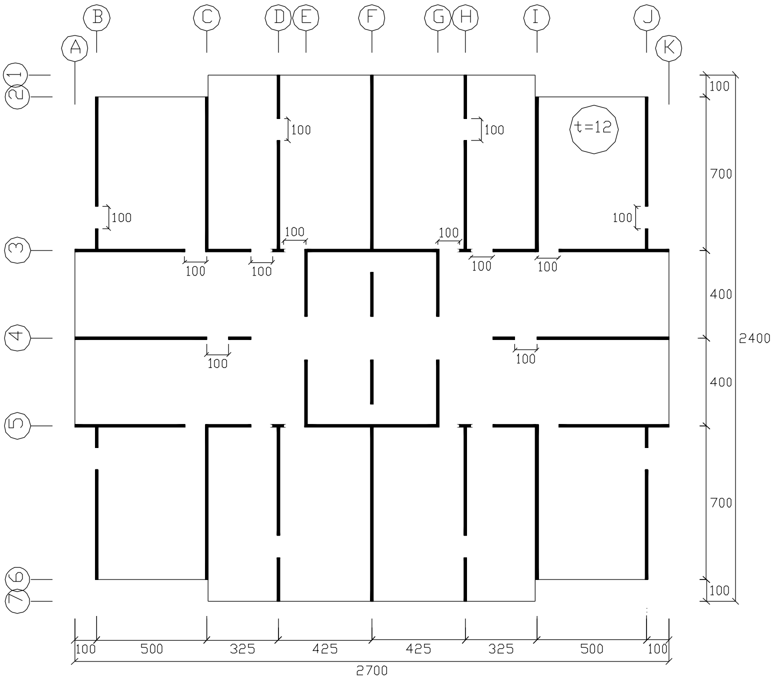

Figure A.14 Typical plan view – Plan No. 15 (units in cm)

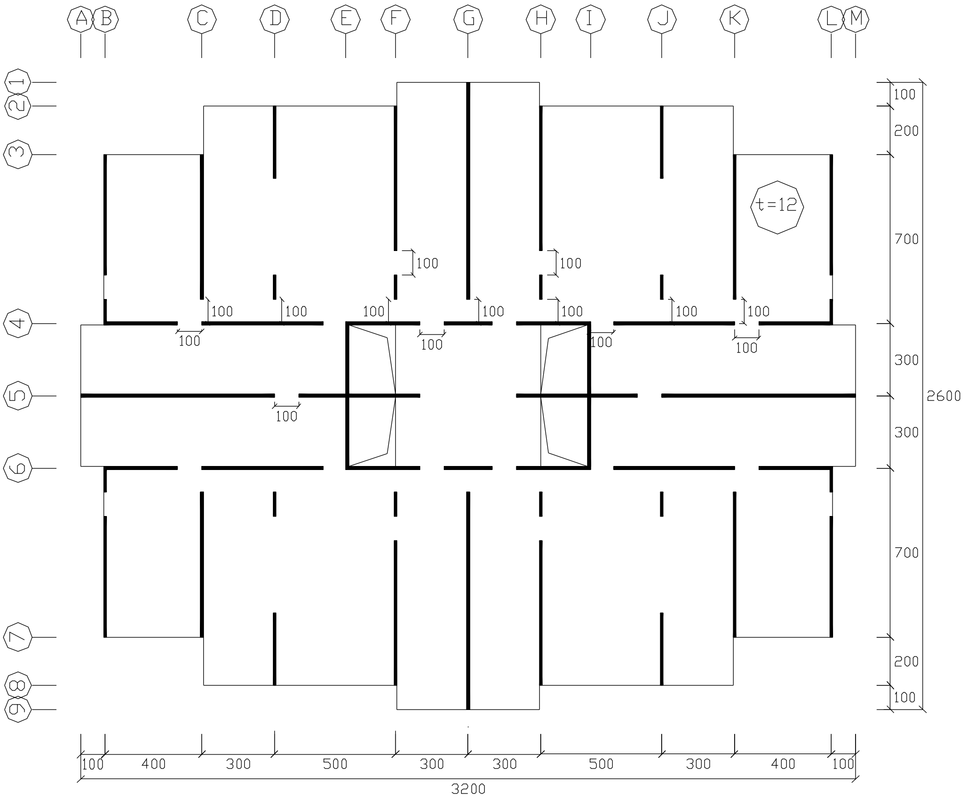

Figure A.15 Typical plan view – Plan No. 16 (units in cm)

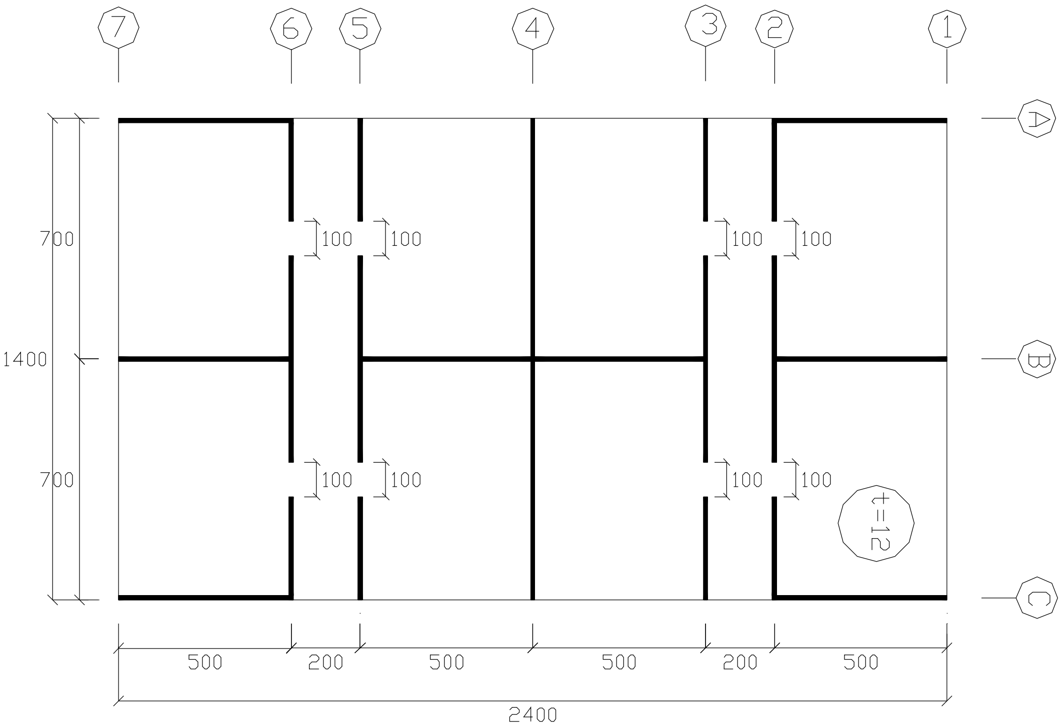

Figure A.16 Typical plan view – Plan No. 17 (units in cm)

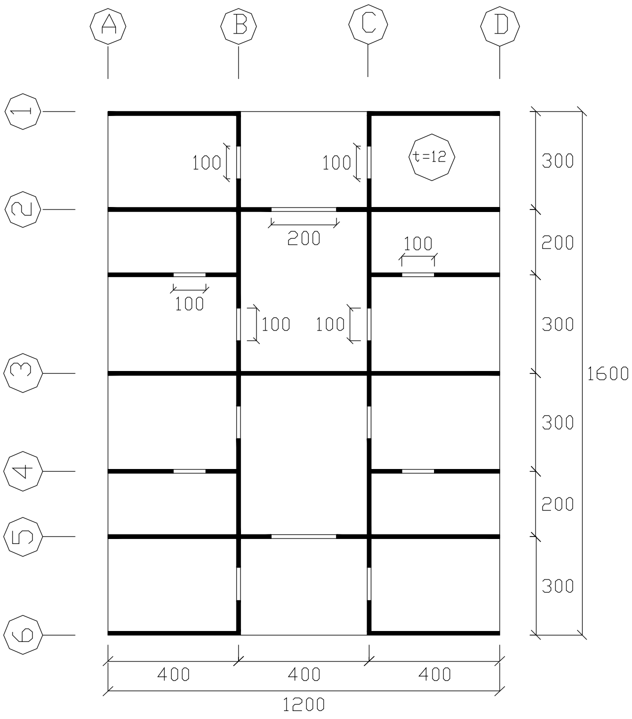

Figure A.17 Typical plan view – Plan No. 18 (units in cm)

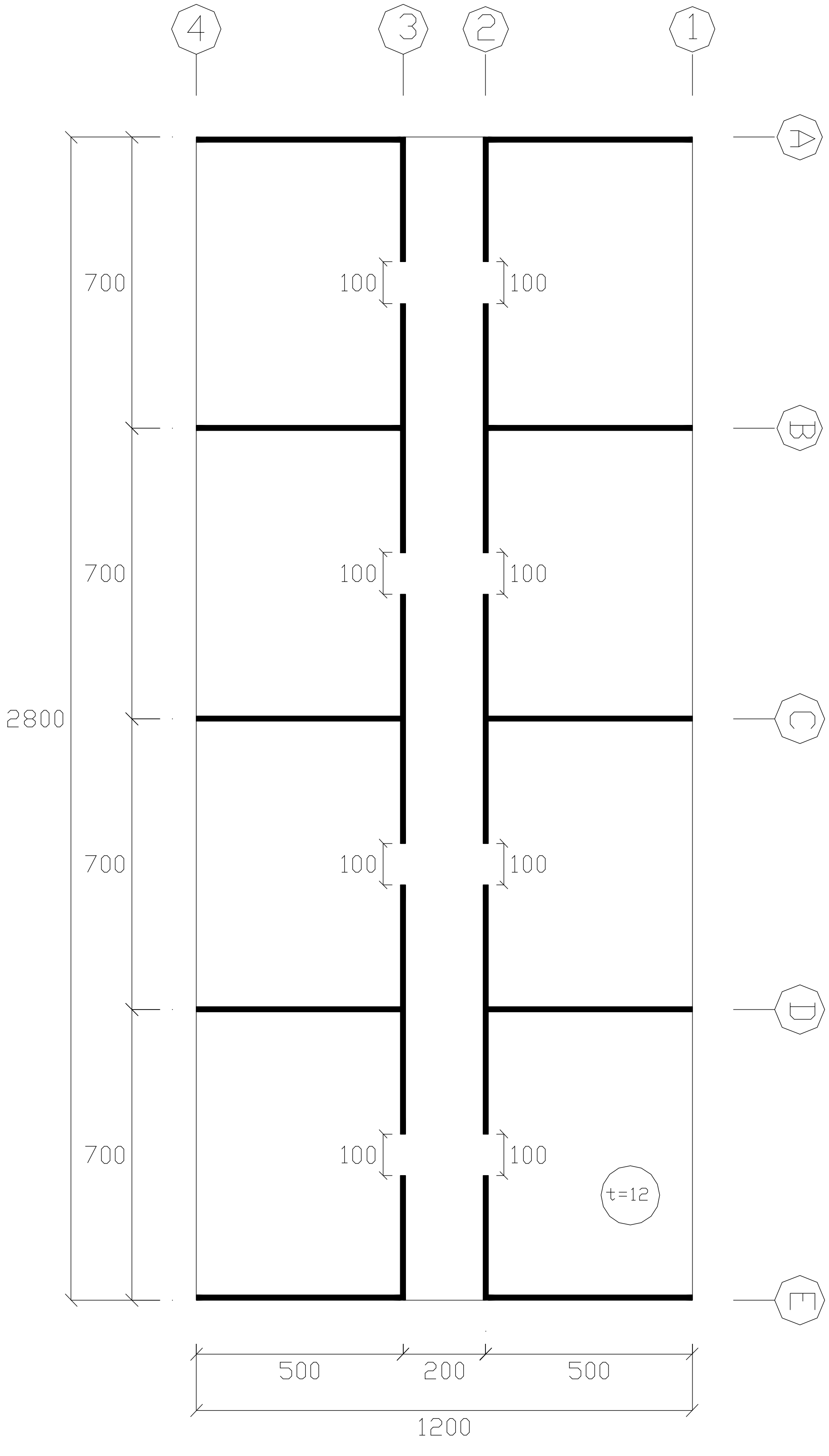

Figure A.18 Typical plan view – Plan No. 19 (units in cm)

B. COMPARISON OF THE PREDICTED PERIODS WITH CODE FORMULAS

Table B.1 Comparison of the predicted periods via Eq.4.2 with UBC (1997) & TSC (1998)

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SB	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
1	5	14,0	29,70	15,70	4,78	17,80	90000	31,70	17,70	0,13	0,16	0,27	0,17	0,17	0,17
	10	28,0	29,70	15,70	4,78	17,80	90000	31,70	17,70	0,29	0,35	0,53	0,48	0,38	0,37
	12	33,6	29,70	15,70	4,78	17,80	90000	31,70	17,70	0,37	0,44	0,64	0,63	0,45	0,44
	15	42,0	29,70	15,70	4,78	17,80	90000	31,70	17,70	0,49	0,58	0,80	0,88	0,55	0,54
	18	50,4	29,70	15,70	5,98	22,25	90000	31,70	17,70	0,70	0,76	1,05	1,15	0,57	0,57
	20	56,0	29,70	15,70	7,97	29,67	90000	31,70	17,70	0,74	0,89	1,31	1,35	0,54	0,54
	25	70,0	29,70	15,70	7,97	29,67	90000	31,70	17,70	1,03	1,27	1,64	1,87	0,65	0,64
2	5	14,0	31,04	19,92	3,40	19,92	90000	33,04	21,92	0,12	0,15	0,20	0,18	0,15	0,15
	10	28,0	31,04	19,92	3,40	19,92	90000	33,04	21,92	0,28	0,32	0,40	0,49	0,35	0,35
	12	33,6	31,04	19,92	3,40	19,92	90000	33,04	21,92	0,35	0,40	0,48	0,64	0,42	0,42
	15	42,0	31,04	19,92	3,40	19,92	90000	33,04	21,92	0,47	0,54	0,60	0,89	0,52	0,52
	18	50,4	31,04	19,92	4,25	24,90	90000	33,04	21,92	0,58	0,67	0,79	1,17	0,55	0,54
	20	56,0	31,04	19,92	5,67	33,20	90000	33,04	21,92	0,64	0,78	0,99	1,36	0,52	0,52
	25	70,0	31,04	19,92	5,67	33,20	90000	33,04	21,92	0,95	1,10	1,24	1,89	0,63	0,62
3	5	14,0	38,80	17,03	3,98	19,60	90000	40,80	19,03	0,14	0,16	0,25	0,17	0,18	0,18
	10	28,0	38,80	17,03	3,98	19,60	90000	40,80	19,03	0,31	0,34	0,49	0,47	0,39	0,39
	12	33,6	38,80	17,03	3,98	19,60	90000	40,80	19,03	0,39	0,42	0,59	0,62	0,47	0,46
	15	42,0	38,80	17,03	3,98	19,60	90000	40,80	19,03	0,50	0,54	0,74	0,86	0,57	0,57
	18	50,4	38,80	17,03	4,98	24,50	90000	40,80	19,03	0,59	0,69	0,97	1,12	0,60	0,59
	20	56,0	38,80	17,03	6,64	32,67	90000	40,80	19,03	0,64	0,81	1,21	1,31	0,57	0,56
	25	70,0	38,80	17,03	6,64	32,67	90000	40,80	19,03	0,93	1,16	1,51	1,82	0,68	0,67
4	5	14,0	12,00	8,00	1,44	2,88	90000	14,00	10,00	0,14	0,16	0,25	0,18	0,32	0,32
	10	28,0	12,00	8,00	1,44	2,88	90000	14,00	10,00	0,35	0,45	0,50	0,51	0,61	0,77
	12	33,6	12,00	8,00	1,44	2,88	90000	14,00	10,00	0,49	0,61	0,60	0,66	0,70	0,94
	15	42,0	12,00	8,00	1,44	2,88	90000	14,00	10,00	0,76	0,90	0,75	0,92	0,82	1,18
	18	50,4	12,00	8,00	1,80	3,60	90000	14,00	10,00	1,01	1,20	0,99	1,20	0,95	1,25
	20	56,0	12,00	8,00	2,40	4,80	90000	14,00	10,00	1,17	1,42	1,23	1,41	1,02	1,18
	25	70,0	12,00	8,00	2,40	4,80	90000	14,00	10,00	1,81	2,11	1,54	1,95	1,21	1,43

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SB	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
5	5	14,0	12,00	8,00	3,84	1,92	90000	14,00	10,00	0,16	0,21	0,28	0,18	0,36	0,42
	10	28,0	12,00	8,00	3,84	1,92	90000	14,00	10,00	0,43	0,48	0,56	0,51	0,61	0,80
	12	33,6	12,00	8,00	3,84	1,92	90000	14,00	10,00	0,55	0,59	0,68	0,66	0,70	0,93
	15	42,0	12,00	8,00	3,84	1,92	90000	14,00	10,00	0,74	0,77	0,84	0,92	0,82	1,12
	18	50,4	12,00	8,00	4,80	2,40	90000	14,00	10,00	0,89	0,96	1,11	1,20	0,95	1,15
	20	56,0	12,00	8,00	6,40	3,20	90000	14,00	10,00	0,97	1,17	1,38	1,41	1,02	1,08
	25	70,0	12,00	8,00	6,40	3,20	90000	14,00	10,00	1,28	1,71	1,73	1,96	1,21	1,29
6	5	14,0	12,00	8,00	1,44	3,84	90000	14,00	10,00	0,11	0,15	0,26	0,18	0,30	0,29
	10	28,0	12,00	8,00	1,44	3,84	90000	14,00	10,00	0,32	0,43	0,53	0,51	0,61	0,71
	12	33,6	12,00	8,00	1,44	3,84	90000	14,00	10,00	0,45	0,58	0,63	0,66	0,70	0,86
	15	42,0	12,00	8,00	1,44	3,84	90000	14,00	10,00	0,69	0,84	0,79	0,92	0,82	1,07
	18	50,4	12,00	8,00	1,80	4,80	90000	14,00	10,00	0,93	1,14	1,04	1,20	0,95	1,13
	20	56,0	12,00	8,00	2,40	6,40	90000	14,00	10,00	1,08	1,36	1,29	1,41	1,02	1,08
	25	70,0	12,00	8,00	2,40	6,40	90000	14,00	10,00	1,68	2,02	1,61	1,95	1,21	1,30
7	5	14,0	12,00	8,00	2,88	2,64	90000	14,00	10,00	0,13	0,17	0,29	0,18	0,36	0,46
	10	28,0	12,00	8,00	2,88	2,64	90000	14,00	10,00	0,35	0,47	0,57	0,51	0,61	0,84
	12	33,6	12,00	8,00	2,88	2,64	90000	14,00	10,00	0,50	0,64	0,69	0,66	0,70	0,97
	15	42,0	12,00	8,00	2,88	2,64	90000	14,00	10,00	0,75	0,92	0,86	0,92	0,82	1,15
	18	50,4	12,00	8,00	3,60	3,30	90000	14,00	10,00	1,02	1,24	1,13	1,20	0,95	1,19
	20	56,0	12,00	8,00	4,80	4,40	90000	14,00	10,00	1,18	1,49	1,40	1,41	1,02	1,11
	25	70,0	12,00	8,00	4,80	4,40	90000	14,00	10,00	1,83	2,20	1,75	1,96	1,21	1,32
8	5	14,0	38,80	17,03	3,98	19,60	90000	40,80	19,03	0,14	0,20	0,25	0,17	0,36	0,44
	10	28,0	38,80	17,03	3,98	19,60	90000	40,80	19,03	0,44	0,51	0,49	0,47	0,61	0,81
	12	33,6	38,80	17,03	3,98	19,60	90000	40,80	19,03	0,58	0,65	0,59	0,62	0,70	0,94
	15	42,0	38,80	17,03	3,98	19,60	90000	40,80	19,03	0,82	0,89	0,74	0,86	0,82	1,12
	18	50,4	38,80	17,03	4,98	24,50	90000	40,80	19,03	1,03	1,17	0,97	1,12	0,95	1,16
	20	56,0	38,80	17,03	6,64	32,67	90000	40,80	19,03	1,15	1,41	1,21	1,31	1,02	1,09
	25	70,0	38,80	17,03	6,64	32,67	90000	40,80	19,03	1,69	2,09	1,51	1,82	1,21	1,29

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SB	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
9	5	14,0	12,00	8,00	4,80	1,92	90000	14,00	10,00	0,16	0,22	0,29	0,18	0,36	0,40
	10	28,0	12,00	8,00	4,80	1,92	90000	14,00	10,00	0,43	0,48	0,58	0,51	0,61	0,75
	12	33,6	12,00	8,00	4,80	1,92	90000	14,00	10,00	0,55	0,59	0,70	0,66	0,70	0,87
	15	42,0	12,00	8,00	4,80	1,92	90000	14,00	10,00	0,74	0,77	0,88	0,92	0,82	1,04
	18	50,4	12,00	8,00	6,00	2,40	90000	14,00	10,00	0,89	1,00	1,15	1,21	0,95	1,07
	20	56,0	12,00	8,00	8,00	3,20	90000	14,00	10,00	0,98	1,23	1,43	1,41	1,01	1,01
	25	70,0	12,00	8,00	8,00	3,20	90000	14,00	10,00	1,28	1,79	1,79	1,96	1,20	1,19
10	5	14,0	35,00	20,00	7,20	12,96	90000	37,00	22,00	0,16	0,18	0,23	0,17	0,17	0,17
	10	28,0	35,00	20,00	7,20	12,96	90000	37,00	22,00	0,38	0,41	0,46	0,48	0,39	0,39
	12	33,6	35,00	20,00	7,20	12,96	90000	37,00	22,00	0,48	0,51	0,55	0,63	0,47	0,46
	15	42,0	35,00	20,00	7,20	12,96	90000	37,00	22,00	0,64	0,67	0,69	0,88	0,57	0,57
	18	50,4	35,00	20,00	9,00	16,20	90000	37,00	22,00	0,80	0,84	0,90	1,15	0,60	0,59
	20	56,0	35,00	20,00	12,00	21,60	90000	37,00	22,00	0,92	0,97	1,12	1,35	0,57	0,56
	25	70,0	35,00	20,00	12,00	21,60	90000	37,00	22,00	1,22	1,28	1,4	1,87	0,68	0,67
11	5	14,0	11,00	9,00	2,64	1,80	90000	13,00	11,00	0,23	0,28	0,23	0,18	0,34	0,33
	10	28,0	11,00	9,00	2,64	1,80	90000	13,00	11,00	0,63	0,68	0,46	0,51	0,61	0,79
	12	33,6	11,00	9,00	2,64	1,80	90000	13,00	11,00	0,82	0,86	0,56	0,67	0,70	0,95
	15	42,0	11,00	9,00	2,64	1,80	90000	13,00	11,00	0,83	1,16	0,69	0,93	0,82	1,18
	18	50,4	11,00	9,00	3,30	2,25	90000	13,00	11,00	1,35	1,38	0,91	1,21	0,95	1,24
	20	56,0	11,00	9,00	4,40	3,00	90000	13,00	11,00	1,44	1,48	1,14	1,42	1,02	1,18
	25	70,0	11,00	9,00	4,40	3,00	90000	13,00	11,00	1,94	2,02	1,42	1,97	1,21	1,42
12	5	14,0	31,50	27,15	9,70	13,86	90000	33,50	29,15	0,16	0,21	0,19	0,18	0,26	0,26
	10	28,0	31,50	27,15	9,70	13,86	90000	33,50	29,15	0,42	0,49	0,37	0,50	0,61	0,63
	12	33,6	31,50	27,15	9,70	13,86	90000	33,50	29,15	0,55	0,63	0,45	0,66	0,70	0,76
	15	42,0	31,50	27,15	9,70	13,86	90000	33,50	29,15	0,77	0,85	0,56	0,92	0,82	0,95
	18	50,4	31,50	27,15	12,13	17,33	90000	33,50	29,15	0,98	1,06	0,73	1,20	0,95	1,00
	20	56,0	31,50	27,15	16,17	23,10	90000	33,50	29,15	1,10	1,20	0,91	1,40	0,96	0,95
	25	70,0	31,50	27,15	16,17	23,10	90000	33,50	29,15	1,54	1,64	1,14	1,95	1,16	1,15

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SB	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
13	5	14,0	25,50	25,04	10,70	10,88	90000	27,50	27,04	0,14	0,20	0,19	0,18	0,19	0,19
	10	28,0	25,50	25,04	10,70	10,88	90000	27,50	27,04	0,40	0,52	0,38	0,51	0,41	0,41
	12	33,6	25,50	25,04	10,70	10,88	90000	27,50	27,04	0,55	0,67	0,46	0,67	0,49	0,48
	15	42,0	25,50	25,04	10,70	10,88	90000	27,50	27,04	0,80	0,93	0,57	0,93	0,59	0,59
	18	50,4	25,50	25,04	13,38	13,60	90000	27,50	27,04	1,03	1,18	0,75	1,22	0,62	0,61
	20	56,0	25,50	25,04	17,83	18,13	90000	27,50	27,04	1,17	1,35	0,94	1,42	0,59	0,58
	25	70,0	25,50	25,04	17,83	18,13	90000	27,50	27,04	1,69	1,85	1,17	1,98	0,70	0,69
14	5	14,0	28,00	12,00	2,88	3,60	90000	30,00	14,00	0,13	0,18	0,23	0,17	0,30	0,29
	10	28,0	28,00	12,00	2,88	3,60	90000	30,00	14,00	0,40	0,47	0,46	0,48	0,57	0,56
	12	33,6	28,00	12,00	2,88	3,60	90000	30,00	14,00	0,54	0,63	0,55	0,62	0,66	0,65
	15	42,0	28,00	12,00	2,88	3,60	90000	30,00	14,00	0,79	0,89	0,69	0,87	0,79	0,78
	18	50,4	28,00	12,00	3,60	4,50	90000	30,00	14,00	1,02	1,15	0,90	1,13	0,81	0,81
	20	56,0	28,00	12,00	4,80	6,00	90000	30,00	14,00	1,16	1,33	1,13	1,33	0,77	0,76
	25	70,0	28,00	12,00	4,80	6,00	90000	30,00	14,00	1,70	1,92	1,41	1,84	0,91	0,90
15	5	14,0	27,00	24,00	8,40	13,55	90000	29,00	26,00	0,17	0,24	0,20	0,18	0,19	0,18
	10	28,0	27,00	24,00	8,40	13,55	90000	29,00	26,00	0,49	0,59	0,39	0,51	0,40	0,39
	12	33,6	27,00	24,00	8,40	13,55	90000	29,00	26,00	0,65	0,75	0,47	0,66	0,47	0,47
	15	42,0	27,00	24,00	8,40	13,55	90000	29,00	26,00	0,92	1,02	0,59	0,92	0,57	0,57
	18	50,4	27,00	24,00	10,50	16,94	90000	29,00	26,00	1,16	1,28	0,78	1,21	0,60	0,59
	20	56,0	27,00	24,00	14,00	22,58	90000	29,00	26,00	1,32	1,46	0,97	1,41	0,57	0,56
	25	70,0	27,00	24,00	14,00	22,58	90000	29,00	26,00	1,84	1,98	1,21	1,96	0,68	0,67
16	5	14,0	32,00	26,00	9,40	15,00	90000	34,00	28,00	0,17	0,23	0,19	0,18	0,17	0,17
	10	28,0	32,00	26,00	9,40	15,00	90000	34,00	28,00	0,49	0,56	0,39	0,50	0,36	0,36
	12	33,6	32,00	26,00	9,40	15,00	90000	34,00	28,00	0,64	0,71	0,47	0,66	0,43	0,43
	15	42,0	32,00	26,00	9,40	15,00	90000	34,00	28,00	0,88	0,95	0,58	0,91	0,53	0,52
	18	50,4	32,00	26,00	11,75	18,75	90000	34,00	28,00	1,10	1,18	0,77	1,19	0,55	0,55
	20	56,0	32,00	26,00	15,67	25,00	90000	34,00	28,00	1,24	1,34	0,96	1,39	0,52	0,51
	25	70,0	32,00	26,00	15,67	25,00	90000	34,00	28,00	1,69	1,78	1,20	1,94	0,62	0,62

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SB	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
17	5	14,0	24,00	14,00	4,80	7,44	90000	26,00	16,00	0,17	0,24	0,25	0,18	0,28	0,28
	10	28,0	24,00	14,00	4,80	7,44	90000	26,00	16,00	0,48	0,58	0,50	0,49	0,55	0,54
	12	33,6	24,00	14,00	4,80	7,44	90000	26,00	16,00	0,63	0,75	0,60	0,64	0,64	0,63
	15	42,0	24,00	14,00	4,80	7,44	90000	26,00	16,00	0,88	1,01	0,75	0,89	0,77	0,76
	18	50,4	24,00	14,00	6,00	9,30	90000	26,00	16,00	1,12	1,28	0,99	1,17	0,79	0,79
	20	56,0	24,00	14,00	8,00	12,40	90000	26,00	16,00	1,29	1,49	1,23	1,36	0,75	0,74
	25	70,0	24,00	14,00	8,00	12,40	90000	26,00	16,00	1,80	2,00	1,54	1,89	0,89	0,88
18	5	14,0	16,00	12,00	3,84	8,16	90000	18,00	14,00	0,11	0,14	0,27	0,18	0,32	0,32
	10	28,0	16,00	12,00	3,84	8,16	90000	18,00	14,00	0,26	0,32	0,54	0,51	0,60	0,60
	12	33,6	16,00	12,00	3,84	8,16	90000	18,00	14,00	0,33	0,43	0,64	0,66	0,70	0,69
	15	42,0	16,00	12,00	3,84	8,16	90000	18,00	14,00	0,45	0,60	0,80	0,92	0,82	0,83
	18	50,4	16,00	12,00	4,80	10,20	90000	18,00	14,00	0,59	0,81	1,06	1,20	0,86	0,85
	20	56,0	16,00	12,00	6,40	13,60	90000	18,00	14,00	0,68	0,98	1,32	1,40	0,81	0,80
	25	70,0	16,00	12,00	6,40	13,60	90000	18,00	14,00	1,03	1,42	1,64	1,95	0,96	0,95
19	5	14,0	28,00	12,00	5,76	6,00	90000	30,00	14,00	0,13	0,18	0,29	0,17	0,30	0,29
	10	28,0	28,00	12,00	5,76	6,00	90000	30,00	14,00	0,40	0,47	0,59	0,48	0,57	0,56
	12	33,6	28,00	12,00	5,76	6,00	90000	30,00	14,00	0,54	0,63	0,70	0,63	0,66	0,65
	15	42,0	28,00	12,00	5,76	6,00	90000	30,00	14,00	0,79	0,88	0,88	0,87	0,79	0,78
	18	50,4	28,00	12,00	7,20	7,50	90000	30,00	14,00	1,02	1,15	1,15	1,14	0,81	0,81
	20	56,0	28,00	12,00	9,60	10,00	90000	30,00	14,00	1,16	1,33	1,44	1,33	0,77	0,76
	25	70,0	28,00	12,00	9,60	10,00	90000	30,00	14,00	1,70	1,92	1,79	1,85	0,91	0,90
20	5	14,0	16,00	12,00	3,84	5,76	90000	18,00	14,00	0,12	0,16	0,25	0,18	0,33	0,33
	10	28,0	16,00	12,00	3,84	5,76	90000	18,00	14,00	0,31	0,35	0,50	0,50	0,61	0,62
	12	33,6	16,00	12,00	3,84	5,76	90000	18,00	14,00	0,39	0,44	0,61	0,66	0,70	0,72
	15	42,0	16,00	12,00	3,84	5,76	90000	18,00	14,00	0,52	0,62	0,76	0,92	0,82	0,87
	18	50,4	16,00	12,00	4,80	7,20	90000	18,00	14,00	0,64	0,83	0,99	1,20	0,90	0,89
	20	56,0	16,00	12,00	6,40	9,60	90000	18,00	14,00	0,73	0,99	1,24	1,40	0,85	0,84
	25	70,0	16,00	12,00	6,40	9,60	90000	18,00	14,00	1,06	1,44	1,55	1,95	1,01	1,00

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SC	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
1	5	14,0	29,70	15,70	4,78	17,80	70000	31,70	17,70	0,13	0,16	0,27	0,18	0,17	0,17
	10	28,0	29,70	15,70	4,78	17,80	70000	31,70	17,70	0,29	0,36	0,53	0,49	0,38	0,37
	12	33,6	29,70	15,70	4,78	17,80	70000	31,70	17,70	0,37	0,44	0,64	0,64	0,45	0,44
	15	42,0	29,70	15,70	4,78	17,80	70000	31,70	17,70	0,49	0,60	0,80	0,88	0,55	0,54
	18	50,4	29,70	15,70	5,98	22,25	70000	31,70	17,70	0,70	0,79	1,05	1,16	0,57	0,57
	20	56,0	29,70	15,70	7,97	29,67	70000	31,70	17,70	0,74	0,93	1,31	1,35	0,54	0,54
	25	70,0	29,70	15,70	7,97	29,67	70000	31,70	17,70	1,03	1,33	1,64	1,88	0,65	0,64
2	5	14,0	31,04	19,92	3,40	19,92	70000	33,04	21,92	0,12	0,15	0,20	0,18	0,15	0,15
	10	28,0	31,04	19,92	3,40	19,92	70000	33,04	21,92	0,28	0,33	0,40	0,49	0,35	0,35
	12	33,6	31,04	19,92	3,40	19,92	70000	33,04	21,92	0,35	0,41	0,48	0,64	0,42	0,42
	15	42,0	31,04	19,92	3,40	19,92	70000	33,04	21,92	0,47	0,55	0,60	0,89	0,52	0,52
	18	50,4	31,04	19,92	4,25	24,90	70000	33,04	21,92	0,58	0,69	0,79	1,17	0,55	0,54
	20	56,0	31,04	19,92	5,67	33,20	70000	33,04	21,92	0,64	0,80	0,99	1,37	0,52	0,52
	25	70,0	31,04	19,92	5,67	33,20	70000	33,04	21,92	0,95	1,14	1,24	1,90	0,63	0,62
3	5	14,0	38,80	17,03	3,98	19,60	70000	40,80	19,03	0,14	0,17	0,25	0,17	0,18	0,18
	10	28,0	38,80	17,03	3,98	19,60	70000	40,80	19,03	0,31	0,34	0,49	0,47	0,39	0,39
	12	33,6	38,80	17,03	3,98	19,60	70000	40,80	19,03	0,39	0,42	0,59	0,62	0,47	0,46
	15	42,0	38,80	17,03	3,98	19,60	70000	40,80	19,03	0,50	0,55	0,74	0,86	0,57	0,57
	18	50,4	38,80	17,03	4,98	24,50	70000	40,80	19,03	0,59	0,72	0,97	1,13	0,60	0,59
	20	56,0	38,80	17,03	6,64	32,67	70000	40,80	19,03	0,64	0,85	1,21	1,32	0,57	0,56
	25	70,0	38,80	17,03	6,64	32,67	70000	40,80	19,03	0,93	1,21	1,51	1,83	0,68	0,67
4	5	14,0	12,00	8,00	1,44	2,88	70000	14,00	10,00	0,14	0,17	0,25	0,18	0,32	0,32
	10	28,0	12,00	8,00	1,44	2,88	70000	14,00	10,00	0,35	0,47	0,50	0,51	0,61	0,77
	12	33,6	12,00	8,00	1,44	2,88	70000	14,00	10,00	0,49	0,64	0,60	0,67	0,70	0,94
	15	42,0	12,00	8,00	1,44	2,88	70000	14,00	10,00	0,76	0,93	0,75	0,92	0,82	1,18
	18	50,4	12,00	8,00	1,80	3,60	70000	14,00	10,00	1,01	1,24	0,99	1,21	0,95	1,25
	20	56,0	12,00	8,00	2,40	4,80	70000	14,00	10,00	1,17	1,47	1,23	1,41	1,02	1,18
	25	70,0	12,00	8,00	2,40	4,80	70000	14,00	10,00	1,81	2,19	1,54	1,96	1,21	1,43

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SC	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
5	5	14,0	12,00	8,00	3,84	1,92	70000	14,00	10,00	0,16	0,22	0,28	0,18	0,36	0,42
	10	28,0	12,00	8,00	3,84	1,92	70000	14,00	10,00	0,43	0,48	0,56	0,51	0,61	0,80
	12	33,6	12,00	8,00	3,84	1,92	70000	14,00	10,00	0,55	0,60	0,68	0,67	0,70	0,93
	15	42,0	12,00	8,00	3,84	1,92	70000	14,00	10,00	0,74	0,77	0,84	0,92	0,82	1,12
	18	50,4	12,00	8,00	4,80	2,40	70000	14,00	10,00	0,89	1,03	1,11	1,21	0,95	1,15
	20	56,0	12,00	8,00	6,40	3,20	70000	14,00	10,00	0,97	1,26	1,38	1,42	1,02	1,08
	25	70,0	12,00	8,00	6,40	3,20	70000	14,00	10,00	1,28	1,82	1,73	1,97	1,21	1,29
6	5	14,0	12,00	8,00	1,44	3,84	70000	14,00	10,00	0,11	0,16	0,26	0,18	0,30	0,29
	10	28,0	12,00	8,00	1,44	3,84	70000	14,00	10,00	0,32	0,45	0,53	0,51	0,61	0,71
	12	33,6	12,00	8,00	1,44	3,84	70000	14,00	10,00	0,45	0,60	0,63	0,67	0,70	0,86
	15	42,0	12,00	8,00	1,44	3,84	70000	14,00	10,00	0,69	0,88	0,79	0,92	0,82	1,07
	18	50,4	12,00	8,00	1,80	4,80	70000	14,00	10,00	0,93	1,19	1,04	1,21	0,95	1,13
	20	56,0	12,00	8,00	2,40	6,40	70000	14,00	10,00	1,08	1,43	1,29	1,41	1,02	1,08
	25	70,0	12,00	8,00	2,40	6,40	70000	14,00	10,00	1,68	2,11	1,61	1,96	1,21	1,30
7	5	14,0	12,00	8,00	2,88	2,64	70000	14,00	10,00	0,13	0,18	0,29	0,18	0,36	0,46
	10	28,0	12,00	8,00	2,88	2,64	70000	14,00	10,00	0,35	0,50	0,57	0,51	0,61	0,84
	12	33,6	12,00	8,00	2,88	2,64	70000	14,00	10,00	0,50	0,67	0,69	0,67	0,70	0,97
	15	42,0	12,00	8,00	2,88	2,64	70000	14,00	10,00	0,75	0,96	0,86	0,92	0,82	1,15
	18	50,4	12,00	8,00	3,60	3,30	70000	14,00	10,00	1,02	1,29	1,13	1,21	0,95	1,19
	20	56,0	12,00	8,00	4,80	4,40	70000	14,00	10,00	1,18	1,55	1,40	1,42	1,02	1,11
	25	70,0	12,00	8,00	4,80	4,40	70000	14,00	10,00	1,83	2,28	1,75	1,97	1,21	1,32
8	5	14,0	38,80	17,03	3,98	19,60	70000	40,80	19,03	0,14	0,21	0,25	0,17	0,36	0,44
	10	28,0	38,80	17,03	3,98	19,60	70000	40,80	19,03	0,44	0,52	0,49	0,47	0,61	0,81
	12	33,6	38,80	17,03	3,98	19,60	70000	40,80	19,03	0,58	0,66	0,59	0,62	0,70	0,94
	15	42,0	38,80	17,03	3,98	19,60	70000	40,80	19,03	0,82	0,90	0,74	0,86	0,82	1,12
	18	50,4	38,80	17,03	4,98	24,50	70000	40,80	19,03	1,03	1,23	0,97	1,13	0,95	1,16
	20	56,0	38,80	17,03	6,64	32,67	70000	40,80	19,03	1,15	1,49	1,21	1,32	1,02	1,09
	25	70,0	38,80	17,03	6,64	32,67	70000	40,80	19,03	1,69	2,19	1,51	1,83	1,21	1,29

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SC	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
9	5	14,0	12,00	8,00	4,80	1,92	70000	14,00	10,00	0,16	0,22	0,29	0,18	0,36	0,40
	10	28,0	12,00	8,00	4,80	1,92	70000	14,00	10,00	0,43	0,48	0,58	0,51	0,61	0,75
	12	33,6	12,00	8,00	4,80	1,92	70000	14,00	10,00	0,55	0,59	0,70	0,67	0,70	0,87
	15	42,0	12,00	8,00	4,80	1,92	70000	14,00	10,00	0,74	0,78	0,88	0,93	0,82	1,04
	18	50,4	12,00	8,00	6,00	2,40	70000	14,00	10,00	0,89	1,07	1,15	1,21	0,95	1,07
	20	56,0	12,00	8,00	8,00	3,20	70000	14,00	10,00	0,98	1,32	1,43	1,42	1,01	1,01
	25	70,0	12,00	8,00	8,00	3,20	70000	14,00	10,00	1,28	1,91	1,79	1,97	1,20	1,19
10	5	14,0	35,00	20,00	7,20	12,96	70000	37,00	22,00	0,16	0,19	0,23	0,18	0,17	0,17
	10	28,0	35,00	20,00	7,20	12,96	70000	37,00	22,00	0,38	0,41	0,46	0,49	0,39	0,39
	12	33,6	35,00	20,00	7,20	12,96	70000	37,00	22,00	0,48	0,51	0,55	0,64	0,47	0,46
	15	42,0	35,00	20,00	7,20	12,96	70000	37,00	22,00	0,64	0,67	0,69	0,88	0,57	0,57
	18	50,4	35,00	20,00	9,00	16,20	70000	37,00	22,00	0,80	0,85	0,90	1,16	0,60	0,59
	20	56,0	35,00	20,00	12,00	21,60	70000	37,00	22,00	0,92	0,98	1,12	1,35	0,57	0,56
	25	70,0	35,00	20,00	12,00	21,60	70000	37,00	22,00	1,22	1,30	1,4	1,88	0,68	0,67
11	5	14,0	11,00	9,00	2,64	1,80	70000	13,00	11,00	0,23	0,29	0,23	0,18	0,34	0,33
	10	28,0	11,00	9,00	2,64	1,80	70000	13,00	11,00	0,63	0,68	0,46	0,51	0,61	0,79
	12	33,6	11,00	9,00	2,64	1,80	70000	13,00	11,00	0,82	0,87	0,56	0,67	0,70	0,95
	15	42,0	11,00	9,00	2,64	1,80	70000	13,00	11,00	0,83	1,16	0,69	0,93	0,82	1,18
	18	50,4	11,00	9,00	3,30	2,25	70000	13,00	11,00	1,35	1,38	0,91	1,22	0,95	1,24
	20	56,0	11,00	9,00	4,40	3,00	70000	13,00	11,00	1,44	1,48	1,14	1,42	1,02	1,18
	25	70,0	11,00	9,00	4,40	3,00	70000	13,00	11,00	1,94	2,07	1,42	1,98	1,21	1,42
12	5	14,0	31,50	27,15	9,70	13,86	70000	33,50	29,15	0,16	0,22	0,19	0,18	0,26	0,26
	10	28,0	31,50	27,15	9,70	13,86	70000	33,50	29,15	0,42	0,51	0,37	0,51	0,61	0,63
	12	33,6	31,50	27,15	9,70	13,86	70000	33,50	29,15	0,55	0,64	0,45	0,66	0,70	0,76
	15	42,0	31,50	27,15	9,70	13,86	70000	33,50	29,15	0,77	0,87	0,56	0,92	0,82	0,95
	18	50,4	31,50	27,15	12,13	17,33	70000	33,50	29,15	0,98	1,08	0,73	1,21	0,95	1,00
	20	56,0	31,50	27,15	16,17	23,10	70000	33,50	29,15	1,10	1,22	0,91	1,41	0,96	0,95
	25	70,0	31,50	27,15	16,17	23,10	70000	33,50	29,15	1,54	1,66	1,14	1,96	1,16	1,15

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SC	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
13	5	14,0	25,50	25,04	10,70	10,88	70000	27,50	27,04	0,14	0,21	0,19	0,19	0,19	0,19
	10	28,0	25,50	25,04	10,70	10,88	70000	27,50	27,04	0,40	0,54	0,38	0,52	0,41	0,41
	12	33,6	25,50	25,04	10,70	10,88	70000	27,50	27,04	0,55	0,70	0,46	0,67	0,49	0,48
	15	42,0	25,50	25,04	10,70	10,88	70000	27,50	27,04	0,80	0,96	0,57	0,94	0,59	0,59
	18	50,4	25,50	25,04	13,38	13,60	70000	27,50	27,04	1,03	1,21	0,75	1,22	0,62	0,61
	20	56,0	25,50	25,04	17,83	18,13	70000	27,50	27,04	1,17	1,38	0,94	1,43	0,59	0,58
	25	70,0	25,50	25,04	17,83	18,13	70000	27,50	27,04	1,69	1,87	1,17	1,99	0,70	0,69
14	5	14,0	28,00	12,00	2,88	3,60	70000	30,00	14,00	0,13	0,19	0,23	0,17	0,30	0,29
	10	28,0	28,00	12,00	2,88	3,60	70000	30,00	14,00	0,40	0,49	0,46	0,48	0,57	0,56
	12	33,6	28,00	12,00	2,88	3,60	70000	30,00	14,00	0,54	0,64	0,55	0,63	0,66	0,65
	15	42,0	28,00	12,00	2,88	3,60	70000	30,00	14,00	0,79	0,91	0,69	0,87	0,79	0,78
	18	50,4	28,00	12,00	3,60	4,50	70000	30,00	14,00	1,02	1,18	0,90	1,14	0,81	0,81
	20	56,0	28,00	12,00	4,80	6,00	70000	30,00	14,00	1,16	1,37	1,13	1,33	0,77	0,76
	25	70,0	28,00	12,00	4,80	6,00	70000	30,00	14,00	1,70	1,97	1,41	1,85	0,91	0,90
15	5	14,0	27,00	24,00	8,40	13,55	70000	29,00	26,00	0,17	0,25	0,20	0,18	0,19	0,18
	10	28,0	27,00	24,00	8,40	13,55	70000	29,00	26,00	0,49	0,60	0,39	0,51	0,40	0,39
	12	33,6	27,00	24,00	8,40	13,55	70000	29,00	26,00	0,65	0,77	0,47	0,67	0,47	0,47
	15	42,0	27,00	24,00	8,40	13,55	70000	29,00	26,00	0,92	1,04	0,59	0,93	0,57	0,57
	18	50,4	27,00	24,00	10,50	16,94	70000	29,00	26,00	1,16	1,30	0,78	1,21	0,60	0,59
	20	56,0	27,00	24,00	14,00	22,58	70000	29,00	26,00	1,32	1,48	0,97	1,42	0,57	0,56
	25	70,0	27,00	24,00	14,00	22,58	70000	29,00	26,00	1,84	1,99	1,21	1,97	0,68	0,67
16	5	14,0	32,00	26,00	9,40	15,00	70000	34,00	28,00	0,17	0,24	0,19	0,18	0,17	0,17
	10	28,0	32,00	26,00	9,40	15,00	70000	34,00	28,00	0,49	0,57	0,39	0,50	0,36	0,36
	12	33,6	32,00	26,00	9,40	15,00	70000	34,00	28,00	0,64	0,72	0,47	0,66	0,43	0,43
	15	42,0	32,00	26,00	9,40	15,00	70000	34,00	28,00	0,88	0,96	0,58	0,92	0,53	0,52
	18	50,4	32,00	26,00	11,75	18,75	70000	34,00	28,00	1,10	1,19	0,77	1,20	0,55	0,55
	20	56,0	32,00	26,00	15,67	25,00	70000	34,00	28,00	1,24	1,35	0,96	1,40	0,52	0,51
	25	70,0	32,00	26,00	15,67	25,00	70000	34,00	28,00	1,69	1,80	1,20	1,95	0,62	0,62

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SC	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
17	5	14,0	24,00	14,00	4,80	7,44	70000	26,00	16,00	0,17	0,25	0,25	0,18	0,28	0,28
	10	28,0	24,00	14,00	4,80	7,44	70000	26,00	16,00	0,48	0,60	0,50	0,49	0,55	0,54
	12	33,6	24,00	14,00	4,80	7,44	70000	26,00	16,00	0,63	0,77	0,60	0,64	0,64	0,63
	15	42,0	24,00	14,00	4,80	7,44	70000	26,00	16,00	0,88	1,03	0,75	0,90	0,77	0,76
	18	50,4	24,00	14,00	6,00	9,30	70000	26,00	16,00	1,12	1,31	0,99	1,17	0,79	0,79
	20	56,0	24,00	14,00	8,00	12,40	70000	26,00	16,00	1,29	1,51	1,23	1,37	0,75	0,74
	25	70,0	24,00	14,00	8,00	12,40	70000	26,00	16,00	1,80	2,03	1,54	1,90	0,89	0,88
18	5	14,0	16,00	12,00	3,84	8,16	70000	18,00	14,00	0,11	0,14	0,27	0,18	0,32	0,32
	10	28,0	16,00	12,00	3,84	8,16	70000	18,00	14,00	0,26	0,34	0,54	0,51	0,60	0,60
	12	33,6	16,00	12,00	3,84	8,16	70000	18,00	14,00	0,33	0,45	0,64	0,66	0,70	0,69
	15	42,0	16,00	12,00	3,84	8,16	70000	18,00	14,00	0,45	0,64	0,80	0,92	0,82	0,83
	18	50,4	16,00	12,00	4,80	10,20	70000	18,00	14,00	0,59	0,86	1,06	1,21	0,86	0,85
	20	56,0	16,00	12,00	6,40	13,60	70000	18,00	14,00	0,68	1,05	1,32	1,41	0,81	0,80
	25	70,0	16,00	12,00	6,40	13,60	70000	18,00	14,00	1,03	1,51	1,64	1,96	0,96	0,95
19	5	14,0	28,00	12,00	5,76	6,00	70000	30,00	14,00	0,13	0,19	0,29	0,17	0,30	0,29
	10	28,0	28,00	12,00	5,76	6,00	70000	30,00	14,00	0,40	0,49	0,59	0,48	0,57	0,56
	12	33,6	28,00	12,00	5,76	6,00	70000	30,00	14,00	0,54	0,64	0,70	0,63	0,66	0,65
	15	42,0	28,00	12,00	5,76	6,00	70000	30,00	14,00	0,79	0,91	0,88	0,87	0,79	0,78
	18	50,4	28,00	12,00	7,20	7,50	70000	30,00	14,00	1,02	1,18	1,15	1,14	0,81	0,81
	20	56,0	28,00	12,00	9,60	10,00	70000	30,00	14,00	1,16	1,37	1,44	1,34	0,77	0,76
	25	70,0	28,00	12,00	9,60	10,00	70000	30,00	14,00	1,70	1,97	1,79	1,85	0,91	0,90
20	5	14,0	16,00	12,00	3,84	5,76	70000	18,00	14,00	0,12	0,16	0,25	0,18	0,33	0,33
	10	28,0	16,00	12,00	3,84	5,76	70000	18,00	14,00	0,31	0,36	0,50	0,51	0,61	0,62
	12	33,6	16,00	12,00	3,84	5,76	70000	18,00	14,00	0,39	0,46	0,61	0,66	0,70	0,72
	15	42,0	16,00	12,00	3,84	5,76	70000	18,00	14,00	0,52	0,65	0,76	0,92	0,82	0,87
	18	50,4	16,00	12,00	4,80	7,20	70000	18,00	14,00	0,64	0,87	0,99	1,21	0,90	0,89
	20	56,0	16,00	12,00	6,40	9,60	70000	18,00	14,00	0,73	1,05	1,24	1,41	0,85	0,84
	25	70,0	16,00	12,00	6,40	9,60	70000	18,00	14,00	1,06	1,52	1,55	1,96	1,01	1,00

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SD	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
1	5	14,0	29,70	15,70	4,78	17,80	40000	31,70	17,70	0,13	0,17	0,27	0,18	0,17	0,17
	10	28,0	29,70	15,70	4,78	17,80	40000	31,70	17,70	0,29	0,37	0,53	0,49	0,38	0,37
	12	33,6	29,70	15,70	4,78	17,80	40000	31,70	17,70	0,37	0,48	0,64	0,64	0,45	0,44
	15	42,0	29,70	15,70	4,78	17,80	40000	31,70	17,70	0,49	0,67	0,80	0,89	0,55	0,54
	18	50,4	29,70	15,70	5,98	22,25	40000	31,70	17,70	0,70	0,89	1,05	1,17	0,57	0,57
	20	56,0	29,70	15,70	7,97	29,67	40000	31,70	17,70	0,74	1,07	1,31	1,37	0,54	0,54
	25	70,0	29,70	15,70	7,97	29,67	40000	31,70	17,70	1,03	1,51	1,64	1,90	0,65	0,64
2	5	14,0	31,04	19,92	3,40	19,92	40000	33,04	21,92	0,12	0,16	0,20	0,18	0,15	0,15
	10	28,0	31,04	19,92	3,40	19,92	40000	33,04	21,92	0,28	0,35	0,40	0,50	0,35	0,35
	12	33,6	31,04	19,92	3,40	19,92	40000	33,04	21,92	0,35	0,44	0,48	0,65	0,42	0,42
	15	42,0	31,04	19,92	3,40	19,92	40000	33,04	21,92	0,47	0,59	0,60	0,91	0,52	0,52
	18	50,4	31,04	19,92	4,25	24,90	40000	33,04	21,92	0,58	0,75	0,79	1,18	0,55	0,54
	20	56,0	31,04	19,92	5,67	33,20	40000	33,04	21,92	0,64	0,89	0,99	1,39	0,52	0,52
	25	70,0	31,04	19,92	5,67	33,20	40000	33,04	21,92	0,95	1,24	1,24	1,92	0,63	0,62
3	5	14,0	38,80	17,03	3,98	19,60	40000	40,80	19,03	0,14	0,17	0,25	0,17	0,18	0,18
	10	28,0	38,80	17,03	3,98	19,60	40000	40,80	19,03	0,31	0,36	0,49	0,48	0,39	0,39
	12	33,6	38,80	17,03	3,98	19,60	40000	40,80	19,03	0,39	0,45	0,59	0,63	0,47	0,46
	15	42,0	38,80	17,03	3,98	19,60	40000	40,80	19,03	0,50	0,61	0,74	0,87	0,57	0,57
	18	50,4	38,80	17,03	4,98	24,50	40000	40,80	19,03	0,59	0,81	0,97	1,14	0,60	0,59
	20	56,0	38,80	17,03	6,64	32,67	40000	40,80	19,03	0,64	0,96	1,21	1,33	0,57	0,56
	25	70,0	38,80	17,03	6,64	32,67	40000	40,80	19,03	0,93	1,34	1,51	1,85	0,68	0,67
4	5	14,0	12,00	8,00	1,44	2,88	40000	14,00	10,00	0,14	0,20	0,25	0,19	0,32	0,32
	10	28,0	12,00	8,00	1,44	2,88	40000	14,00	10,00	0,35	0,53	0,50	0,51	0,61	0,77
	12	33,6	12,00	8,00	1,44	2,88	40000	14,00	10,00	0,49	0,71	0,60	0,67	0,70	0,94
	15	42,0	12,00	8,00	1,44	2,88	40000	14,00	10,00	0,76	1,02	0,75	0,93	0,82	1,18
	18	50,4	12,00	8,00	1,80	3,60	40000	14,00	10,00	1,01	1,38	0,99	1,22	0,95	1,25
	20	56,0	12,00	8,00	2,40	4,80	40000	14,00	10,00	1,17	1,65	1,23	1,43	1,02	1,18
	25	70,0	12,00	8,00	2,40	4,80	40000	14,00	10,00	1,81	2,42	1,54	1,98	1,21	1,43

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SD	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
5	5	14,0	12,00	8,00	3,84	1,92	40000	14,00	10,00	0,16	0,24	0,28	0,19	0,36	0,42
	10	28,0	12,00	8,00	3,84	1,92	40000	14,00	10,00	0,43	0,49	0,56	0,52	0,61	0,80
	12	33,6	12,00	8,00	3,84	1,92	40000	14,00	10,00	0,55	0,63	0,68	0,67	0,70	0,93
	15	42,0	12,00	8,00	3,84	1,92	40000	14,00	10,00	0,74	0,89	0,84	0,94	0,82	1,12
	18	50,4	12,00	8,00	4,80	2,40	40000	14,00	10,00	0,89	1,21	1,11	1,22	0,95	1,15
	20	56,0	12,00	8,00	6,40	3,20	40000	14,00	10,00	0,97	1,51	1,38	1,43	1,02	1,08
	25	70,0	12,00	8,00	6,40	3,20	40000	14,00	10,00	1,28	2,16	1,73	1,99	1,21	1,29
6	5	14,0	12,00	8,00	1,44	3,84	40000	14,00	10,00	0,11	0,19	0,26	0,19	0,30	0,29
	10	28,0	12,00	8,00	1,44	3,84	40000	14,00	10,00	0,32	0,51	0,53	0,51	0,61	0,71
	12	33,6	12,00	8,00	1,44	3,84	40000	14,00	10,00	0,45	0,69	0,63	0,67	0,70	0,86
	15	42,0	12,00	8,00	1,44	3,84	40000	14,00	10,00	0,69	0,98	0,79	0,93	0,82	1,07
	18	50,4	12,00	8,00	1,80	4,80	40000	14,00	10,00	0,93	1,34	1,04	1,22	0,95	1,13
	20	56,0	12,00	8,00	2,40	6,40	40000	14,00	10,00	1,08	1,63	1,29	1,43	1,02	1,08
	25	70,0	12,00	8,00	2,40	6,40	40000	14,00	10,00	1,68	2,38	1,61	1,99	1,21	1,30
7	5	14,0	12,00	8,00	2,88	2,64	40000	14,00	10,00	0,13	0,21	0,29	0,19	0,36	0,46
	10	28,0	12,00	8,00	2,88	2,64	40000	14,00	10,00	0,35	0,57	0,57	0,52	0,61	0,84
	12	33,6	12,00	8,00	2,88	2,64	40000	14,00	10,00	0,50	0,75	0,69	0,67	0,70	0,97
	15	42,0	12,00	8,00	2,88	2,64	40000	14,00	10,00	0,75	1,07	0,86	0,94	0,82	1,15
	18	50,4	12,00	8,00	3,60	3,30	40000	14,00	10,00	1,02	1,45	1,13	1,22	0,95	1,19
	20	56,0	12,00	8,00	4,80	4,40	40000	14,00	10,00	1,18	1,76	1,40	1,43	1,02	1,11
	25	70,0	12,00	8,00	4,80	4,40	40000	14,00	10,00	1,83	2,55	1,75	1,99	1,21	1,32
8	5	14,0	38,80	17,03	3,98	19,60	40000	40,80	19,03	0,14	0,23	0,25	0,17	0,36	0,44
	10	28,0	38,80	17,03	3,98	19,60	40000	40,80	19,03	0,44	0,54	0,49	0,48	0,61	0,81
	12	33,6	38,80	17,03	3,98	19,60	40000	40,80	19,03	0,58	0,71	0,59	0,63	0,70	0,94
	15	42,0	38,80	17,03	3,98	19,60	40000	40,80	19,03	0,82	1,02	0,74	0,87	0,82	1,12
	18	50,4	38,80	17,03	4,98	24,50	40000	40,80	19,03	1,03	1,40	0,97	1,14	0,95	1,16
	20	56,0	38,80	17,03	6,64	32,67	40000	40,80	19,03	1,15	1,71	1,21	1,33	1,02	1,09
	25	70,0	38,80	17,03	6,64	32,67	40000	40,80	19,03	1,69	2,49	1,51	1,85	1,21	1,29

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SD	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
9	5	14,0	12,00	8,00	4,80	1,92	40000	14,00	10,00	0,16	0,24	0,29	0,19	0,36	0,40
	10	28,0	12,00	8,00	4,80	1,92	40000	14,00	10,00	0,43	0,50	0,58	0,52	0,61	0,75
	12	33,6	12,00	8,00	4,80	1,92	40000	14,00	10,00	0,55	0,65	0,70	0,67	0,70	0,87
	15	42,0	12,00	8,00	4,80	1,92	40000	14,00	10,00	0,74	0,92	0,88	0,94	0,82	1,04
	18	50,4	12,00	8,00	6,00	2,40	40000	14,00	10,00	0,89	1,27	1,15	1,22	0,95	1,07
	20	56,0	12,00	8,00	8,00	3,20	40000	14,00	10,00	0,98	1,58	1,43	1,43	1,01	1,01
	25	70,0	12,00	8,00	8,00	3,20	40000	14,00	10,00	1,28	2,27	1,79	1,99	1,20	1,19
10	5	14,0	35,00	20,00	7,20	12,96	40000	37,00	22,00	0,16	0,19	0,23	0,18	0,17	0,17
	10	28,0	35,00	20,00	7,20	12,96	40000	37,00	22,00	0,38	0,42	0,46	0,49	0,39	0,39
	12	33,6	35,00	20,00	7,20	12,96	40000	37,00	22,00	0,48	0,53	0,55	0,64	0,47	0,46
	15	42,0	35,00	20,00	7,20	12,96	40000	37,00	22,00	0,64	0,69	0,69	0,89	0,57	0,57
	18	50,4	35,00	20,00	9,00	16,20	40000	37,00	22,00	0,80	0,87	0,90	1,17	0,60	0,59
	20	56,0	35,00	20,00	12,00	21,60	40000	37,00	22,00	0,92	1,02	1,12	1,37	0,57	0,56
	25	70,0	35,00	20,00	12,00	21,60	40000	37,00	22,00	1,22	1,40	1,4	1,90	0,68	0,67
11	5	14,0	11,00	9,00	2,64	1,80	40000	13,00	11,00	0,23	0,31	0,23	0,19	0,34	0,33
	10	28,0	11,00	9,00	2,64	1,80	40000	13,00	11,00	0,63	0,70	0,46	0,52	0,61	0,79
	12	33,6	11,00	9,00	2,64	1,80	40000	13,00	11,00	0,82	0,88	0,56	0,68	0,70	0,95
	15	42,0	11,00	9,00	2,64	1,80	40000	13,00	11,00	0,83	1,17	0,69	0,94	0,82	1,18
	18	50,4	11,00	9,00	3,30	2,25	40000	13,00	11,00	1,35	1,39	0,91	1,23	0,95	1,24
	20	56,0	11,00	9,00	4,40	3,00	40000	13,00	11,00	1,44	1,55	1,14	1,44	1,02	1,18
	25	70,0	11,00	9,00	4,40	3,00	40000	13,00	11,00	1,94	2,25	1,42	2,00	1,21	1,42
12	5	14,0	31,50	27,15	9,70	13,86	40000	33,50	29,15	0,16	0,24	0,19	0,19	0,26	0,26
	10	28,0	31,50	27,15	9,70	13,86	40000	33,50	29,15	0,42	0,54	0,37	0,51	0,61	0,63
	12	33,6	31,50	27,15	9,70	13,86	40000	33,50	29,15	0,55	0,68	0,45	0,67	0,70	0,76
	15	42,0	31,50	27,15	9,70	13,86	40000	33,50	29,15	0,77	0,90	0,56	0,93	0,82	0,95
	18	50,4	31,50	27,15	12,13	17,33	40000	33,50	29,15	0,98	1,12	0,73	1,22	0,95	1,00
	20	56,0	31,50	27,15	16,17	23,10	40000	33,50	29,15	1,10	1,27	0,91	1,43	0,96	0,95
	25	70,0	31,50	27,15	16,17	23,10	40000	33,50	29,15	1,54	1,72	1,14	1,98	1,16	1,15

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SD	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
13	5	14,0	25,50	25,04	10,70	10,88	40000	27,50	27,04	0,14	0,24	0,19	0,19	0,19	0,19
	10	28,0	25,50	25,04	10,70	10,88	40000	27,50	27,04	0,40	0,59	0,38	0,52	0,41	0,41
	12	33,6	25,50	25,04	10,70	10,88	40000	27,50	27,04	0,55	0,76	0,46	0,68	0,49	0,48
	15	42,0	25,50	25,04	10,70	10,88	40000	27,50	27,04	0,80	1,01	0,57	0,95	0,59	0,59
	18	50,4	25,50	25,04	13,38	13,60	40000	27,50	27,04	1,03	1,26	0,75	1,24	0,62	0,61
	20	56,0	25,50	25,04	17,83	18,13	40000	27,50	27,04	1,17	1,44	0,94	1,45	0,59	0,58
	25	70,0	25,50	25,04	17,83	18,13	40000	27,50	27,04	1,69	1,92	1,17	2,01	0,70	0,69
14	5	14,0	28,00	12,00	2,88	3,60	40000	30,00	14,00	0,13	0,19	0,23	0,17	0,30	0,29
	10	28,0	28,00	12,00	2,88	3,60	40000	30,00	14,00	0,40	0,53	0,46	0,48	0,57	0,56
	12	33,6	28,00	12,00	2,88	3,60	40000	30,00	14,00	0,54	0,69	0,55	0,63	0,66	0,65
	15	42,0	28,00	12,00	2,88	3,60	40000	30,00	14,00	0,79	0,97	0,69	0,88	0,79	0,78
	18	50,4	28,00	12,00	3,60	4,50	40000	30,00	14,00	1,02	1,27	0,90	1,15	0,81	0,81
	20	56,0	28,00	12,00	4,80	6,00	40000	30,00	14,00	1,16	1,50	1,13	1,35	0,77	0,76
	25	70,0	28,00	12,00	4,80	6,00	40000	30,00	14,00	1,70	2,14	1,41	1,87	0,91	0,90
15	5	14,0	27,00	24,00	8,40	13,55	40000	29,00	26,00	0,17	0,27	0,20	0,19	0,19	0,18
	10	28,0	27,00	24,00	8,40	13,55	40000	29,00	26,00	0,49	0,65	0,39	0,52	0,40	0,39
	12	33,6	27,00	24,00	8,40	13,55	40000	29,00	26,00	0,65	0,82	0,47	0,67	0,47	0,47
	15	42,0	27,00	24,00	8,40	13,55	40000	29,00	26,00	0,92	1,08	0,59	0,94	0,57	0,57
	18	50,4	27,00	24,00	10,50	16,94	40000	29,00	26,00	1,16	1,34	0,78	1,23	0,60	0,59
	20	56,0	27,00	24,00	14,00	22,58	40000	29,00	26,00	1,32	1,52	0,97	1,43	0,57	0,56
	25	70,0	27,00	24,00	14,00	22,58	40000	29,00	26,00	1,84	2,02	1,21	1,99	0,68	0,67
16	5	14,0	32,00	26,00	9,40	15,00	40000	34,00	28,00	0,17	0,26	0,19	0,18	0,17	0,17
	10	28,0	32,00	26,00	9,40	15,00	40000	34,00	28,00	0,49	0,60	0,39	0,51	0,36	0,36
	12	33,6	32,00	26,00	9,40	15,00	40000	34,00	28,00	0,64	0,75	0,47	0,67	0,43	0,43
	15	42,0	32,00	26,00	9,40	15,00	40000	34,00	28,00	0,88	0,99	0,58	0,93	0,53	0,52
	18	50,4	32,00	26,00	11,75	18,75	40000	34,00	28,00	1,10	1,22	0,77	1,21	0,55	0,55
	20	56,0	32,00	26,00	15,67	25,00	40000	34,00	28,00	1,24	1,39	0,96	1,42	0,52	0,51
	25	70,0	32,00	26,00	15,67	25,00	40000	34,00	28,00	1,69	1,84	1,20	1,97	0,62	0,62

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SD	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
17	5	14,0	24,00	14,00	4,80	7,44	40000	26,00	16,00	0,17	0,28	0,25	0,18	0,28	0,28
	10	28,0	24,00	14,00	4,80	7,44	40000	26,00	16,00	0,48	0,65	0,50	0,50	0,55	0,54
	12	33,6	24,00	14,00	4,80	7,44	40000	26,00	16,00	0,63	0,83	0,60	0,65	0,64	0,63
	15	42,0	24,00	14,00	4,80	7,44	40000	26,00	16,00	0,88	0,98	0,75	0,91	0,77	0,76
	18	50,4	24,00	14,00	6,00	9,30	40000	26,00	16,00	1,12	1,37	0,99	1,19	0,79	0,79
	20	56,0	24,00	14,00	8,00	12,40	40000	26,00	16,00	1,29	1,59	1,23	1,39	0,75	0,74
	25	70,0	24,00	14,00	8,00	12,40	40000	26,00	16,00	1,80	2,09	1,54	1,92	0,89	0,88
18	5	14,0	16,00	12,00	3,84	8,16	40000	18,00	14,00	0,11	0,15	0,27	0,19	0,32	0,32
	10	28,0	16,00	12,00	3,84	8,16	40000	18,00	14,00	0,26	0,40	0,54	0,51	0,60	0,60
	12	33,6	16,00	12,00	3,84	8,16	40000	18,00	14,00	0,33	0,53	0,64	0,67	0,70	0,69
	15	42,0	16,00	12,00	3,84	8,16	40000	18,00	14,00	0,45	0,74	0,80	0,93	0,82	0,83
	18	50,4	16,00	12,00	4,80	10,20	40000	18,00	14,00	0,59	1,01	1,06	1,22	0,86	0,85
	20	56,0	16,00	12,00	6,40	13,60	40000	18,00	14,00	0,68	1,25	1,32	1,43	0,81	0,80
	25	70,0	16,00	12,00	6,40	13,60	40000	18,00	14,00	1,03	1,78	1,64	1,98	0,96	0,95
19	5	14,0	28,00	12,00	5,76	6,00	40000	30,00	14,00	0,13	0,21	0,29	0,18	0,30	0,29
	10	28,0	28,00	12,00	5,76	6,00	40000	30,00	14,00	0,40	0,53	0,59	0,49	0,57	0,56
	12	33,6	28,00	12,00	5,76	6,00	40000	30,00	14,00	0,54	0,69	0,70	0,64	0,66	0,65
	15	42,0	28,00	12,00	5,76	6,00	40000	30,00	14,00	0,79	0,97	0,88	0,88	0,79	0,78
	18	50,4	28,00	12,00	7,20	7,50	40000	30,00	14,00	1,02	1,27	1,15	1,16	0,81	0,81
	20	56,0	28,00	12,00	9,60	10,00	40000	30,00	14,00	1,16	1,50	1,44	1,35	0,77	0,76
	25	70,0	28,00	12,00	9,60	10,00	40000	30,00	14,00	1,70	2,14	1,79	1,88	0,91	0,90
20	5	14,0	16,00	12,00	3,84	5,76	40000	18,00	14,00	0,12	0,17	0,25	0,19	0,33	0,33
	10	28,0	16,00	12,00	3,84	5,76	40000	18,00	14,00	0,31	0,40	0,50	0,51	0,61	0,62
	12	33,6	16,00	12,00	3,84	5,76	40000	18,00	14,00	0,39	0,53	0,61	0,67	0,70	0,72
	15	42,0	16,00	12,00	3,84	5,76	40000	18,00	14,00	0,52	0,74	0,76	0,93	0,82	0,87
	18	50,4	16,00	12,00	4,80	7,20	40000	18,00	14,00	0,64	1,00	0,99	1,22	0,90	0,89
	20	56,0	16,00	12,00	6,40	9,60	40000	18,00	14,00	0,73	1,22	1,24	1,43	0,85	0,84
	25	70,0	16,00	12,00	6,40	9,60	40000	18,00	14,00	1,06	1,75	1,55	1,98	1,01	1,00

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SE	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
1	5	14,0	29,70	15,70	4,78	17,80	20000	31,70	17,70	0,13	0,19	0,27	0,18	0,17	0,17
	10	28,0	29,70	15,70	4,78	17,80	20000	31,70	17,70	0,29	0,45	0,53	0,50	0,38	0,37
	12	33,6	29,70	15,70	4,78	17,80	20000	31,70	17,70	0,37	0,58	0,64	0,65	0,45	0,44
	15	42,0	29,70	15,70	4,78	17,80	20000	31,70	17,70	0,49	0,81	0,80	0,91	0,55	0,54
	18	50,4	29,70	15,70	5,98	22,25	20000	31,70	17,70	0,70	1,09	1,05	1,19	0,57	0,57
	20	56,0	29,70	15,70	7,97	29,67	20000	31,70	17,70	0,74	1,33	1,31	1,39	0,54	0,54
	25	70,0	29,70	15,70	7,97	29,67	20000	31,70	17,70	1,03	1,88	1,64	1,93	0,65	0,64
2	5	14,0	31,04	19,92	3,40	19,92	20000	33,04	21,92	0,12	0,18	0,20	0,18	0,15	0,15
	10	28,0	31,04	19,92	3,40	19,92	20000	33,04	21,92	0,28	0,39	0,40	0,51	0,35	0,35
	12	33,6	31,04	19,92	3,40	19,92	20000	33,04	21,92	0,35	0,50	0,48	0,66	0,42	0,42
	15	42,0	31,04	19,92	3,40	19,92	20000	33,04	21,92	0,47	0,67	0,60	0,92	0,52	0,52
	18	50,4	31,04	19,92	4,25	24,90	20000	33,04	21,92	0,58	0,87	0,79	1,20	0,55	0,54
	20	56,0	31,04	19,92	5,67	33,20	20000	33,04	21,92	0,64	1,03	0,99	1,40	0,52	0,52
	25	70,0	31,04	19,92	5,67	33,20	20000	33,04	21,92	0,95	1,41	1,24	1,95	0,63	0,62
3	5	14,0	38,80	17,03	3,98	19,60	20000	40,80	19,03	0,14	0,18	0,25	0,18	0,18	0,18
	10	28,0	38,80	17,03	3,98	19,60	20000	40,80	19,03	0,31	0,41	0,49	0,49	0,39	0,39
	12	33,6	38,80	17,03	3,98	19,60	20000	40,80	19,03	0,39	0,53	0,59	0,64	0,47	0,46
	15	42,0	38,80	17,03	3,98	19,60	20000	40,80	19,03	0,50	0,73	0,74	0,88	0,57	0,57
	18	50,4	38,80	17,03	4,98	24,50	20000	40,80	19,03	0,59	0,96	0,97	1,16	0,60	0,59
	20	56,0	38,80	17,03	6,64	32,67	20000	40,80	19,03	0,64	1,17	1,21	1,35	0,57	0,56
	25	70,0	38,80	17,03	6,64	32,67	20000	40,80	19,03	0,93	1,66	1,51	1,88	0,68	0,67
4	5	14,0	12,00	8,00	1,44	2,88	20000	14,00	10,00	0,14	0,25	0,25	0,19	0,32	0,32
	10	28,0	12,00	8,00	1,44	2,88	20000	14,00	10,00	0,35	0,65	0,50	0,52	0,61	0,77
	12	33,6	12,00	8,00	1,44	2,88	20000	14,00	10,00	0,49	0,86	0,60	0,68	0,70	0,94
	15	42,0	12,00	8,00	1,44	2,88	20000	14,00	10,00	0,76	1,21	0,75	0,95	0,82	1,18
	18	50,4	12,00	8,00	1,80	3,60	20000	14,00	10,00	1,01	1,64	0,99	1,24	0,95	1,25
	20	56,0	12,00	8,00	2,40	4,80	20000	14,00	10,00	1,17	2,01	1,23	1,45	1,02	1,18
	25	70,0	12,00	8,00	2,40	4,80	20000	14,00	10,00	1,81	2,89	1,54	2,01	1,21	1,43

Table B.1 continued

Plan No.	No. of story	Height (m)	Plan dimension (m)		Shear-wall area (m^2)		Cu (kN/m^3)	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
			Length	Width	Length	Width		Length	Width	T(s)-Fixed	T(s)-SE	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
5	5	14,0	12,00	8,00	3,84	1,92	20000	14,00	10,00	0,16	0,25	0,28	0,19	0,36	0,42
	10	28,0	12,00	8,00	3,84	1,92	20000	14,00	10,00	0,43	0,62	0,56	0,52	0,61	0,80
	12	33,6	12,00	8,00	3,84	1,92	20000	14,00	10,00	0,55	0,81	0,68	0,68	0,70	0,93
	15	42,0	12,00	8,00	3,84	1,92	20000	14,00	10,00	0,74	1,13	0,84	0,95	0,82	1,12
	18	50,4	12,00	8,00	4,80	2,40	20000	14,00	10,00	0,89	1,57	1,11	1,24	0,95	1,15
	20	56,0	12,00	8,00	6,40	3,20	20000	14,00	10,00	0,97	1,97	1,38	1,45	1,02	1,08
	25	70,0	12,00	8,00	6,40	3,20	20000	14,00	10,00	1,28	2,79	1,73	2,02	1,21	1,29
6	5	14,0	12,00	8,00	1,44	3,84	20000	14,00	10,00	0,11	0,24	0,26	0,19	0,30	0,29
	10	28,0	12,00	8,00	1,44	3,84	20000	14,00	10,00	0,32	0,64	0,53	0,52	0,61	0,71
	12	33,6	12,00	8,00	1,44	3,84	20000	14,00	10,00	0,45	0,84	0,63	0,68	0,70	0,86
	15	42,0	12,00	8,00	1,44	3,84	20000	14,00	10,00	0,69	1,20	0,79	0,95	0,82	1,07
	18	50,4	12,00	8,00	1,80	4,80	20000	14,00	10,00	0,93	1,64	1,04	1,24	0,95	1,13
	20	56,0	12,00	8,00	2,40	6,40	20000	14,00	10,00	1,08	2,03	1,29	1,45	1,02	1,08
	25	70,0	12,00	8,00	2,40	6,40	20000	14,00	10,00	1,68	2,91	1,61	2,01	1,21	1,30
7	5	14,0	12,00	8,00	2,88	2,64	20000	14,00	10,00	0,13	0,27	0,29	0,19	0,36	0,46
	10	28,0	12,00	8,00	2,88	2,64	20000	14,00	10,00	0,35	0,70	0,57	0,52	0,61	0,84
	12	33,6	12,00	8,00	2,88	2,64	20000	14,00	10,00	0,50	0,91	0,69	0,68	0,70	0,97
	15	42,0	12,00	8,00	2,88	2,64	20000	14,00	10,00	0,75	1,28	0,86	0,95	0,82	1,15
	18	50,4	12,00	8,00	3,60	3,30	20000	14,00	10,00	1,02	1,75	1,13	1,24	0,95	1,19
	20	56,0	12,00	8,00	4,80	4,40	20000	14,00	10,00	1,18	2,16	1,40	1,45	1,02	1,11
	25	70,0	12,00	8,00	4,80	4,40	20000	14,00	10,00	1,83	3,09	1,75	2,02	1,21	1,32
8	5	14,0	38,80	17,03	3,98	19,60	20000	40,80	19,03	0,14	0,26	0,25	0,18	0,36	0,44
	10	28,0	38,80	17,03	3,98	19,60	20000	40,80	19,03	0,44	0,67	0,49	0,49	0,61	0,81
	12	33,6	38,80	17,03	3,98	19,60	20000	40,80	19,03	0,58	0,89	0,59	0,64	0,70	0,94
	15	42,0	38,80	17,03	3,98	19,60	20000	40,80	19,03	0,82	1,25	0,74	0,88	0,82	1,12
	18	50,4	38,80	17,03	4,98	24,50	20000	40,80	19,03	1,03	1,72	0,97	1,16	0,95	1,16
	20	56,0	38,80	17,03	6,64	32,67	20000	40,80	19,03	1,15	2,15	1,21	1,35	1,02	1,09
	25	70,0	38,80	17,03	6,64	32,67	20000	40,80	19,03	1,69	3,07	1,51	1,88	1,21	1,29

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SE	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
9	5	14,0	12,00	8,00	4,80	1,92	20000	14,00	10,00	0,16	0,25	0,29	0,19	0,36	0,40
	10	28,0	12,00	8,00	4,80	1,92	20000	14,00	10,00	0,43	0,64	0,58	0,52	0,61	0,75
	12	33,6	12,00	8,00	4,80	1,92	20000	14,00	10,00	0,55	0,84	0,70	0,68	0,70	0,87
	15	42,0	12,00	8,00	4,80	1,92	20000	14,00	10,00	0,74	1,18	0,88	0,95	0,82	1,04
	18	50,4	12,00	8,00	6,00	2,40	20000	14,00	10,00	0,89	1,64	1,15	1,24	0,95	1,07
	20	56,0	12,00	8,00	8,00	3,20	20000	14,00	10,00	0,98	2,08	1,43	1,45	1,01	1,01
	25	70,0	12,00	8,00	8,00	3,20	20000	14,00	10,00	1,28	2,94	1,79	2,02	1,20	1,19
10	5	14,0	35,00	20,00	7,20	12,96	20000	37,00	22,00	0,16	0,20	0,23	0,18	0,17	0,17
	10	28,0	35,00	20,00	7,20	12,96	20000	37,00	22,00	0,38	0,44	0,46	0,50	0,39	0,39
	12	33,6	35,00	20,00	7,20	12,96	20000	37,00	22,00	0,48	0,56	0,55	0,65	0,47	0,46
	15	42,0	35,00	20,00	7,20	12,96	20000	37,00	22,00	0,64	0,76	0,69	0,91	0,57	0,57
	18	50,4	35,00	20,00	9,00	16,20	20000	37,00	22,00	0,80	0,99	0,90	1,19	0,60	0,59
	20	56,0	35,00	20,00	12,00	21,60	20000	37,00	22,00	0,92	1,17	1,12	1,39	0,57	0,56
	25	70,0	35,00	20,00	12,00	21,60	20000	37,00	22,00	1,22	1,61	1,4	1,93	0,68	0,67
11	5	14,0	11,00	9,00	2,64	1,80	20000	13,00	11,00	0,23	0,34	0,23	0,19	0,34	0,33
	10	28,0	11,00	9,00	2,64	1,80	20000	13,00	11,00	0,63	0,72	0,46	0,53	0,61	0,79
	12	33,6	11,00	9,00	2,64	1,80	20000	13,00	11,00	0,82	0,90	0,56	0,69	0,70	0,95
	15	42,0	11,00	9,00	2,64	1,80	20000	13,00	11,00	0,83	1,18	0,69	0,95	0,82	1,18
	18	50,4	11,00	9,00	3,30	2,25	20000	13,00	11,00	1,35	1,52	0,91	1,25	0,95	1,24
	20	56,0	11,00	9,00	4,40	3,00	20000	13,00	11,00	1,44	1,82	1,14	1,46	1,02	1,18
	25	70,0	11,00	9,00	4,40	3,00	20000	13,00	11,00	1,94	2,61	1,42	2,03	1,21	1,42
12	5	14,0	31,50	27,15	9,70	13,86	20000	33,50	29,15	0,16	0,27	0,19	0,19	0,26	0,26
	10	28,0	31,50	27,15	9,70	13,86	20000	33,50	29,15	0,42	0,59	0,37	0,52	0,61	0,63
	12	33,6	31,50	27,15	9,70	13,86	20000	33,50	29,15	0,55	0,73	0,45	0,68	0,70	0,76
	15	42,0	31,50	27,15	9,70	13,86	20000	33,50	29,15	0,77	0,96	0,56	0,94	0,82	0,95
	18	50,4	31,50	27,15	12,13	17,33	20000	33,50	29,15	0,98	1,19	0,73	1,24	0,95	1,00
	20	56,0	31,50	27,15	16,17	23,10	20000	33,50	29,15	1,10	1,36	0,91	1,45	0,96	0,95
	25	70,0	31,50	27,15	16,17	23,10	20000	33,50	29,15	1,54	1,80	1,14	2,01	1,16	1,15

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SE	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
13	5	14,0	25,50	25,04	10,70	10,88	20000	27,50	27,04	0,14	0,29	0,19	0,19	0,19	0,19
	10	28,0	25,50	25,04	10,70	10,88	20000	27,50	27,04	0,40	0,68	0,38	0,53	0,41	0,41
	12	33,6	25,50	25,04	10,70	10,88	20000	27,50	27,04	0,55	0,85	0,46	0,69	0,49	0,48
	15	42,0	25,50	25,04	10,70	10,88	20000	27,50	27,04	0,80	1,09	0,57	0,96	0,59	0,59
	18	50,4	25,50	25,04	13,38	13,60	20000	27,50	27,04	1,03	1,33	0,75	1,26	0,62	0,61
	20	56,0	25,50	25,04	17,83	18,13	20000	27,50	27,04	1,17	1,51	0,94	1,47	0,59	0,58
	25	70,0	25,50	25,04	17,83	18,13	20000	27,50	27,04	1,69	1,96	1,17	2,04	0,70	0,69
14	5	14,0	28,00	12,00	2,88	3,60	20000	30,00	14,00	0,13	0,25	0,23	0,18	0,30	0,29
	10	28,0	28,00	12,00	2,88	3,60	20000	30,00	14,00	0,40	0,61	0,46	0,49	0,57	0,56
	12	33,6	28,00	12,00	2,88	3,60	20000	30,00	14,00	0,54	0,79	0,55	0,64	0,66	0,65
	15	42,0	28,00	12,00	2,88	3,60	20000	30,00	14,00	0,79	1,11	0,69	0,89	0,79	0,78
	18	50,4	28,00	12,00	3,60	4,50	20000	30,00	14,00	1,02	1,47	0,90	1,17	0,81	0,81
	20	56,0	28,00	12,00	4,80	6,00	20000	30,00	14,00	1,16	1,76	1,13	1,37	0,77	0,76
	25	70,0	28,00	12,00	4,80	6,00	20000	30,00	14,00	1,70	2,49	1,41	1,90	0,91	0,90
15	5	14,0	27,00	24,00	8,40	13,55	20000	29,00	26,00	0,17	0,32	0,20	0,19	0,19	0,18
	10	28,0	27,00	24,00	8,40	13,55	20000	29,00	26,00	0,49	0,71	0,39	0,52	0,40	0,39
	12	33,6	27,00	24,00	8,40	13,55	20000	29,00	26,00	0,65	0,88	0,47	0,68	0,47	0,47
	15	42,0	27,00	24,00	8,40	13,55	20000	29,00	26,00	0,92	1,14	0,59	0,95	0,57	0,57
	18	50,4	27,00	24,00	10,50	16,94	20000	29,00	26,00	1,16	1,38	0,78	1,24	0,60	0,59
	20	56,0	27,00	24,00	14,00	22,58	20000	29,00	26,00	1,32	1,57	0,97	1,45	0,57	0,56
	25	70,0	27,00	24,00	14,00	22,58	20000	29,00	26,00	1,84	2,05	1,21	2,02	0,68	0,67
16	5	14,0	32,00	26,00	9,40	15,00	20000	34,00	28,00	0,17	0,29	0,19	0,19	0,17	0,17
	10	28,0	32,00	26,00	9,40	15,00	20000	34,00	28,00	0,49	0,64	0,39	0,52	0,36	0,36
	12	33,6	32,00	26,00	9,40	15,00	20000	34,00	28,00	0,64	0,80	0,47	0,68	0,43	0,43
	15	42,0	32,00	26,00	9,40	15,00	20000	34,00	28,00	0,88	1,04	0,58	0,94	0,53	0,52
	18	50,4	32,00	26,00	11,75	18,75	20000	34,00	28,00	1,10	1,28	0,77	1,23	0,55	0,55
	20	56,0	32,00	26,00	15,67	25,00	20000	34,00	28,00	1,24	1,46	0,96	1,44	0,52	0,51
	25	70,0	32,00	26,00	15,67	25,00	20000	34,00	28,00	1,69	1,91	1,20	2,00	0,62	0,62

Table B.1 continued

Plan No.	No. of	Height	Plan dimension (m)		Shear-wall area (m^2)		Cu	Foundation dimensions(m)		FEM results		Predicted period, T(s)			
	story	(m)	Length	Width	Length	Width	(kN/m^3)	Length	Width	T(s)-Fixed	T(s)-SE	Eq.(4.1)	Eq.(4.2)	TSC98	UBC97
17	5	14,0	24,00	14,00	4,80	7,44	20000	26,00	16,00	0,17	0,32	0,25	0,18	0,28	0,28
	10	28,0	24,00	14,00	4,80	7,44	20000	26,00	16,00	0,48	0,74	0,50	0,51	0,55	0,54
	12	33,6	24,00	14,00	4,80	7,44	20000	26,00	16,00	0,63	0,92	0,60	0,66	0,64	0,63
	15	42,0	24,00	14,00	4,80	7,44	20000	26,00	16,00	0,88	1,19	0,75	0,92	0,77	0,76
	18	50,4	24,00	14,00	6,00	9,30	20000	26,00	16,00	1,12	1,46	0,99	1,20	0,79	0,79
	20	56,0	24,00	14,00	8,00	12,40	20000	26,00	16,00	1,29	1,67	1,23	1,41	0,75	0,74
	25	70,0	24,00	14,00	8,00	12,40	20000	26,00	16,00	1,80	2,17	1,54	1,95	0,89	0,88
18	5	14,0	16,00	12,00	3,84	8,16	20000	18,00	14,00	0,11	0,19	0,27	0,19	0,32	0,32
	10	28,0	16,00	12,00	3,84	8,16	20000	18,00	14,00	0,26	0,51	0,54	0,52	0,60	0,60
	12	33,6	16,00	12,00	3,84	8,16	20000	18,00	14,00	0,33	0,67	0,64	0,68	0,70	0,69
	15	42,0	16,00	12,00	3,84	8,16	20000	18,00	14,00	0,45	0,94	0,80	0,94	0,82	0,83
	18	50,4	16,00	12,00	4,80	10,20	20000	18,00	14,00	0,59	1,29	1,06	1,24	0,86	0,85
	20	56,0	16,00	12,00	6,40	13,60	20000	18,00	14,00	0,68	1,62	1,32	1,45	0,81	0,80
	25	70,0	16,00	12,00	6,40	13,60	20000	18,00	14,00	1,03	2,29	1,64	2,01	0,96	0,95
19	5	14,0	28,00	12,00	5,76	6,00	20000	30,00	14,00	0,13	0,25	0,29	0,18	0,30	0,29
	10	28,0	28,00	12,00	5,76	6,00	20000	30,00	14,00	0,40	0,61	0,59	0,49	0,57	0,56
	12	33,6	28,00	12,00	5,76	6,00	20000	30,00	14,00	0,54	0,79	0,70	0,64	0,66	0,65
	15	42,0	28,00	12,00	5,76	6,00	20000	30,00	14,00	0,79	1,11	0,88	0,89	0,79	0,78
	18	50,4	28,00	12,00	7,20	7,50	20000	30,00	14,00	1,02	1,47	1,15	1,17	0,81	0,81
	20	56,0	28,00	12,00	9,60	10,00	20000	30,00	14,00	1,16	1,76	1,44	1,37	0,77	0,76
	25	70,0	28,00	12,00	9,60	10,00	20000	30,00	14,00	1,70	2,49	1,79	1,90	0,91	0,90
20	5	14,0	16,00	12,00	3,84	5,76	20000	18,00	14,00	0,12	0,19	0,25	0,19	0,33	0,33
	10	28,0	16,00	12,00	3,84	5,76	20000	18,00	14,00	0,31	0,50	0,50	0,52	0,61	0,62
	12	33,6	16,00	12,00	3,84	5,76	20000	18,00	14,00	0,39	0,66	0,61	0,68	0,70	0,72
	15	42,0	16,00	12,00	3,84	5,76	20000	18,00	14,00	0,52	0,92	0,76	0,94	0,82	0,87
	18	50,4	16,00	12,00	4,80	7,20	20000	18,00	14,00	0,64	1,26	0,99	1,24	0,90	0,89
	20	56,0	16,00	12,00	6,40	9,60	20000	18,00	14,00	0,73	1,56	1,24	1,45	0,85	0,84
	25	70,0	16,00	12,00	6,40	9,60	20000	18,00	14,00	1,06	2,21	1,55	2,01	1,01	1,00