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偏心梁柱接頭之剪力強度預測

Shear Strength Prediction of Eccentric Beam-Column Joints Using Softened Strut-and-Tie Model

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ABSTRACT

Several studies showed that the eccentricity between beam and column connections has a detrimental effect on the joint shear strength. With regard to this issue, current ACI 318-08 code restricts the average shear stress on a horizontal plane within the joint, which equals to the effective joint width times column depth. The formula of effective joint width given in ACI 318-08 may be too conservative for eccentric beam-column joints.

This thesis suggests a more rational formula of effective joint width associated with the softened strut-and-tie (SST) model for eccentric beam-column joints. Using the proposed effective joint width, the shear strength predictions of SST model agreed well with the results of 18 eccentric joint specimens failed in shear.

Several available definitions of effective joint width are also used together with proposed effective joint width to estimate joint shear strength using the average joint shear stress limits given in ACI 318-08 design equation. This combination was successfully verified with available 126 beam-column joints with or without eccentricity in literature. Analysis shows that proposed effective joint width can well predict joint shear strength of eccentrically connected beam-column joints and preserves the accuracy of current adopted effective joint width in ACI 318-08. Furthermore, some sensitivity analysis are performed to justify several assumptions.

Keywords : eccentric beam-column joint, effective joint width, shear strength, softened strut-and-tie

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上主是我的牧者，我實在一無所缺（聖詠 23:1）

CONTENTS

ABSTRACT ……………………………………………………………………………..i

ACKNOWLEDGMENT …………………………………………………………...iii

LIST OF TABLES ……………………………………………………………………vii

LIST OF FIGURES …………………………………………………………………...ix

CHAPTER I INTRODUCTION

1.1 Background ……………………………………………………………………….1

1.2 Research Objectives ……………………………………………………………3

1.3 Organization of Thesis …………………………………………………………3

CHAPTER II LITERATURE REVIEW

2.1 Joint Shear Strength per ACI 352R-02 ……………………………………...6

2.2 Joint Shear Strength per ACI 318-08 ………………………………………..8

2.3 Effective Joint Width per AIJ Guideline 1999 ……………………………8

2.4 Effective Joint Width per New Zealand Standard ………………………...9

2.5 Effective Joint Width as Proposed by LaFave et al………………………10

2.6 Softened Strut-and- Tie Model …………………………….…………10

CHAPTER III BEAM-COLUMN JOINT DATABASE

3.1 Column ……………………………………………………………………..15

3.2 Main Beam ……………………………………………………………………17

3.3 Joints ……………………………………………………………………..19

3.4 Transverse Beam ……………………………………………………...20

3.5 Slab …………………………………………………………………………22

3.6 Load-Deflection Backbone Curve ……………………………………….23

3.7 Database Characteristics …………………………………………………23

CHAPTER IV SOFTENED STRUT-AND-TIE MODEL FOR ECCENTRIC JOINTS

4.1 Derivation of Effective Joint Width and Strut Depth ……………………………27

4.2 Test Verification For Eccentric Joints Using Softened Strut-and-Tie Model …...29

CHAPTER V DESIGN IMPLEMENTATIONS

5.1 Simplification of Proposed Effective Joint Width ………………………………34

5.2 Test Verification For Concentric Exterior Joints ………………………………..34

5.3 Test Verification For Concentric Interior Joints ………………………………...37

5.4 Test Verification For Eccentric Joints …………………………………………...38

5.5 Sensitivity Analysis ………………………………………………………………..39

CHAPTER VI CONCLUSIONS 43

NOTATIONS 46

REFERENCES 49

TABLES 58

FIGURES 73

APPENDIX A : DATABASE STORAGE FOR BEAM-COLUMN JOINTS

APPENDIX B : EXAMPLE ON DETAILED CALCULATION USING SST MODEL

APPENDIX C : STRENGTH RATIO FOR EXTERIOR JOINTS CALCULATED USING ℓ_{dh}

LIST OF TABLES

Table 2-1 Values of γ for beam-column joints with continuous column per ACI 352R-02 …………………………………………………………………...58

Table 4-1 Specimen parameters for eccentric beam-column joints …………………….59

Table 4-2 Three tiers of SST analysis for eccentric beam-column joints ………………60

Table 4-3 Statistical value of shear strength ratios between experimental and predicted values for eccentric joints using SST analysis ………………………………61

Table 5-1 Specimen parameters for concentric exterior joints …………………………62

Table 5-2 Statistical value for shear strength ratios between experimental and predicted values for concentric exterior joints …………………………………………65

Table 5-3 Specimen parameters for concentric interior joints ………………………….67

Table 5-4 Statistical value for shear strength ratios between experimental and predicted values for concentric interior joints …………………………………………….70

Table 5-5 Statistical value for shear strength ratios between experimental and predicted values for eccentric joints ……………………………………………………72

Table A-1 Database storage for eccentric beam-column joints

Table A-2 Database storage for concentric interior beam-column joints

Table A-3 Database storage for concentric exterior beam-column joints

Table B-1 Calculation example using softened strut-and-tie model

Table C-1 Statistical value for shear strength ratios between experimental and predicted values for concentric exterior joints using ℓ_{dh}

LIST OF FIGURES

Figure 1-1 Typical eccentric RC beam-column joints ………………………………..73

Figure 1-2 Illustration on wide column-narrow beam connection ………………………73

Figure 2-1 Horizontal acting shear forces ……………………………………………….74

Figure 2-2 Shear resisting mechanisms …………………………………………………74

Figure 2-3 Illustrative determination of b_j per ACI 352R-02 ………………………….75

Figure 2-4 Illustrative determination of b_j per ACI 318-08 ……………………………75

Figure 2-5 Illustrative determination of b_j per AIJ Guideline 1999 ……………………76

Figure 2-6 Illustrative determination of b_j per NZS 3101 ……………………………...76

Figure 2-7 Softened strut-and-tie model …………………………………………………...77

Figure 2-8 Solution algorithm for general SST approach ……………………………….78

Figure 3-1 General joint geometry and coordinate convention …………………………79

Figure 3-2 Typical side view 2-D interior joint …………………………………………80

Figure 3-3 Cross section of column and beam …………………………………………….81

Figure 3-4 Types of transverse reinforcement ……………………………………………82

Figure 3-5 Transverse beam and slab ……………………………………………………..83

Figure 3-6 Types of loading input ………………………………………………………84

Figure 3-7 Database characteristics for beam-column joints based on geometry ………85

Figure 3-8 Database characteristics for concentric exterior beam-column joints ………86

Figure 3-9 Database characteristics for concentric interior beam-column joints ……….87

Figure 3-10 Database characteristics for eccentric beam-column joints …………………88

Figure 3-11 Joint shear strength ratio vs no. of specimens for concentric joints …………89

Figure 4-1 Schematic view of diagonal compressive strut within joint …………………90

Figure 4-2 Illustration on determination of the strut area ……………………………….90

Figure 5-1 Strength ratio vs no. of specimens for concentric exterior joints …………....91

Figure 5-2 Strength ratio vs no. of specimens for concentric interior joints 92

Figure 5-3 Strength ratio vs no. of specimens for eccentric joints …………...................93

Figure 5-4 Sensitivity analysis for Paulay and Priestley Equation with varying axial load ratio ……………………………………………………………………..94

Figure 5-5 Sensitivity analysis for different definitions of b_j …………………………...95

Figure B-1 Detailing of specimen UM-60

CHAPTER I

INTRODUCTION

1.1 Background

In the seismic design philosophy of buildings, plastic hinges are expected to be at beam ends to ensure good energy dissipation during earthquakes. This causes very large forces to be transferred among elements through the beam-column joints. Although concentric connections are more desirable to guarantee a smooth force transfer, eccentric connections (as shown in Fig. 1-1) are sometimes unavoidable due to architectural considerations.

The presence of eccentricity between the beam centerline and column centerline has been found to be detrimental. During the Tokachioki Earthquake in 1968, Joh et al. (1991) found that several reinforced concrete (RC) frame buildings which had eccentric joints were heavily damaged. Goto and Joh (2003) reported similar findings from the Hyogoken-Nanbu earthquake in 1995.

On the other hand, future trend of civil engineering development may move towards the use of high strength material for building designs. This may cause a smaller beam size needed to resist every storey load. Meanwhile, the construction of high rise buildings may still need a large column dimension to resist accumulated axial load. Here, the connection between narrow beam and wide column as depicted in Fig. 1-2 may become an issue as the current

ACI 318-08 code equation may overestimate the joint width by taking the whole column width to be effective.

The current ACI 318-08 design equation to estimate the joint shear strength is using the average shear stress approach, by limiting the effective joint area. In other words, limiting the effective joint area also means limiting the effective joint width. The ACI 318-08 addresses the issue of joint eccentricity by strictly limiting the effective joint width to be equal to the beam width if beams are flush with columns. Meanwhile, The ACI 352R-02 further introduced the eccentricity between the column and beam axes in the design equations. The recent study by LaFave et al. (2005) concluded that the ACI 318-05 code gives a very conservative provision for the effective joint width. Whilst, ACI 352R-02 was reported to be less conservative in terms of the effective joint width and only addresses that issue to a limited extent. Based on comparisons with test data, LaFave et al. (2005) suggested that the effective joint width can be taken as the average between the beam and column width for the ACI 318-05 code provision, yielding reasonable estimations of shear strength for eccentric beam-column joints.

From the current adopted equations to determine effective joint width, they are realized to be based on empirical approach. Therefore, there is a need to use a more analytical approach to estimate the joint strength, as well as to develop a more rational effective joint width.

Among the available joint analytical models, Hwang and Lee (1999, 2000) developed a softened strut-and-tie model (SST) as an analytical approach for predicting the shear strength of concentric joints. This model assumes the failure criteria as the concrete crushing in the nodal zone. Meanwhile, in addition to satisfying the force equilibrium, SST model also satisfies the Mohr's compatibility, and softened reinforced concrete constitutive laws. On the basis of previously developed SST analytical model, the effective joint width is derived and further simplified to suit the current average shear stress approach adopted in ACI 318-08.

1.2 Research Objective

The main objectives of this thesis are:

- To develop a more rational effective joint width based on the available SST model.
- To simplify the rationally derived effective joint width to be compatible with the ACI 318-08 approach to estimate the joint shear strength.
- To develop a database consisting of concentrically and eccentrically connected for both interior and exterior joints for experimental verifications and further research.

1.3 Organization of Thesis

This thesis will be divided into six chapters. The first chapter describes about the research background and its objectives. The literature review as explained in chapter two describes about current ACI 318-08 and ACI 352-02 approaches for estimating joint strength, the effective joint width adopted in AIJ Guideline and New Zealand Standard, as well as the brief theoretical background of softened strut-and-tie model (SST). Chapter three serves as the manual on how the joint research databases are stored in Appendix A. Experimental verifications between the predicted value using SST model and the combination of proposed effective joint width with ACI 318-08 design approach are the main part of chapter four and chapter five, respectively. Finally, chapter six contains the conclusion of this work.

CHAPTER II

LITERATURE REVIEW

This chapter contains a review of the main concepts used in this research work. More emphasis is put on the current design approach adopted in several countries and the brief theoretical background for softened strut-and-tie model.

The typical internal shear force in joints can be described in Fig. 2-1. From the free body diagram, the horizontal shear force acting in the joints can be calculated as

$$V_{jh} = C_s' + C_c' + T - V_{col} = C_s + C_c + T' - V_{col} \qquad (2\text{-}1)$$

Where C_s and C_s' are the compression force coming from compression steel bar, C_c and C_c' are the beam compression force, T and T' are tension force acting at center of tensile reinforcement bars, and V_{col} is the column shear force or storey force.

In order to resist the horizontal shear force, in general, there are two main mechanisms acknowledged so far, i.e. the truss mechanisms (Fig. 2-2a) and the diagonal strut mechanisms (Fig. 2-2b). In the truss mechanisms, all forces will be introduced into the joint by bond stress, hence this concept requires good anchorage length for rebar and relatively high amount of joint transverse reinforcement to maintain joint strength. The other approach, diagonal strut mechanism, the horizontal shear strength is provided by the compressive strut introduced into the joint through beam and column compression blocks. Consequently, the second approach requires less joint transverse reinforcement as compared to the first one, because it is only needed to confine concrete properly.

Meanwhile, Hwang and Lee (1999, 2000, 2002) and Hwang et al. (2005), in their softened strut-and-tie model which satisfies equilibrium, compatibility, and constitutive laws of cracked reinforced concrete, the joint hoops act as tension ties, provide additional load path for shear transfer beside the main diagonal strut, and also to retrain the crack width and therefore retard the softening process of cracked reinforced concrete.

Most of the available design codes adopt the average shear stress concept by limiting the effective joint area, and consequently is limiting the effective joint width. The following sections show the current design equations used in several codes and guidelines, and more importantly is the definition of effective joint width.

2.1 Joint Shear Strength per ACI 352R-02

The ACI 352R-02 design recommendation is the basis for current beam-column joint design practice in US. This design recommendation uses an average shear stress approach to estimate the joint shear strength. ACI 352-02 divides the joint into two types, which are Type 1 and Type 2 connections. Type 1 connection is for joints not designed to sustain strength under deformation reversals into the inelastic range and therefore is allowed to have higher shear stress compared to Type 2 connections. Meanwhile, Type 2 connection is for joints designed to sustain strength under deformation reversals into the inelastic range.

The joint shear strength, V_j is estimated through Eq. (2-2) as follow

$$V_j = 0.083\gamma\sqrt{f_c'}b_j h_c \tag{2-2}$$

. where γ is a constant to account for the confinement effect provided by framing beams, f_c' is the concrete cylinder compressive strength, b_j is the effective joint width, and h_c is the column depth in the direction of joint shear being considered

A member that frames into a face is considered to provide confinement effect to the joint if at least three-quarters of the face of the joint is covered by the framing members. The values of γ is given in Table 2-1.

The effective joint width, b_j, should not exceed the smallest of

$$b_j = \frac{b_b + b_c}{2} \tag{2-3a}$$

$$b_j = b_b + \sum \frac{mh_c}{2} \tag{2-3b}$$

$$b_j = b_c \tag{2-3c}$$

where b_b is the width of the longitudinal beam, e is the eccentricity between the beam centerline and column centroid, and b_c is the width of column. The value of m depends on the eccentricity. If $e > b_c/8$, the value of m is taken to be 0.3. Otherwise, it is equal to 0.5. The illustrative figure for determining effective joint width could be found in Fig. 2-3

2.2 Joint Shear Strength per ACI 318-08

Chapter 21 of ACI 318-08 code for seismic resistant design of buildings uses the same design equation (Eq. 2-2) as suggested by ACI 352R-02 recommendation to estimate the shear strength of Type 2 beam-column joints. Similar to ACI 352R-02 design guideline, this code relies mainly on diagonal strut mechanisms because severe bond deterioration is assumed to occur. However, ACI 318-08 adopts different way to determine the effective joint width. The effective joint width, b_j, per ACI 318-08 is given as:

$$b_j = b_b + h_c \tag{2-4a}$$

$$b_j = b_b + 2x \tag{2-4b}$$

where h_c is the depth of column, and x is taken to be the smaller perpendicular distance from longitudinal axis of beam to column side. The effective joint width should be taken to be the smallest among Eq. (2-4a), (2-4b), and (2-3c).The illustrative figure is given in Fig. 2-4.

2.3 Effective joint width per AIJ Guideline 1999

The current design practice for earthquake resistant design of reinforced concrete structures in Japan is reflected in the AIJ Guideline (1999). Otani (1991) pointed out that AIJ guideline adopts diagonal strut action as the main resisting mechanisms. The design equation for determining the joint shear strength is not the same as that in ACI 318-08 and ACI 352R-02. However, this thesis will not further discuss the difference between the two. This thesis is interested in the determination of effective joint width suggested by AIJ Guideline.

The AIJ Guideline gives the effective joint width, b_j, as follows

$$b_j = b_b + b_{a1} + b_{a2} \tag{2-5a}$$

where b_{ai} is given as follow for each side :

$$b_{ai} = \min\{\frac{x_i}{2};\frac{h_c}{4}\} \tag{2-5b}$$

The illustrative definition of effective joint width per AIJ Guideline is given in Fig 2-5.

2.4 Effective joint width per New Zealand Standard

In the New Zealand Standard 3101 (1995), the effective joint width used to estimate the horizontal shear stress occurred at the joint is the smaller between Eq. (2-6) and Eq. (2-3c).

$$b_j = b_b + 0.5h_c \tag{2-6}$$

But, if eccentricity between beam centerline and column centroid exists, then the effective joint width is given as

$$b_j = 0.5(b_b + b_c + 0.5h_c) - e \tag{2-7}$$

The illustrative definition per NZS 3101 is given in Fig.2-6.

2.5 Effective joint width as proposed by LaFave et al. (2005)

As far as the effective joint width for eccentric joints is concerned, the latest research on this area was done by LaFave et al. (2005). From the collected eccentric beam-column joint specimens, they proposed that by using the current ACI 318-08 design equation (Eq. 2-2) for estimating the shear strength of joint, the effective joint width taken as the average between the column and beam width as given in Eq. (2-3a) gives good agreements with test data.

2.6 Softened strut-and-tie model

As has been explained in Chapter I, the current design equations adopted in codes are usually based on empirical approach by limiting the effective joint width. One of the disadvantages of using empirical equation is that it may not valid in general sense. Therefore, an analytical model is needed.

A common strut-and-tie model applied to joint region usually only satisfies the equilibrium condition (Hsu 1996). However, Hwang and Lee (1999, 2000) further developed a strut-and-tie (SST) model which satisfies the equilibrium criteria (Fig. 2-7a), the two dimensional strain compatibility condition (Fig. 2-7b) and the softened reinforced concrete constitutive laws (Fig. 2-7c). Figure 2-8 gives a conceptual solution procedure for the general SST approach (Hwang and Lee 1999, 2000). However, this approach requires a trial-and-error procedure to obtain a convergent solution and is therefore difficult to use in practice.

Hwang and Lee (2002) further simplified the solution procedure and suggested that the joint shear strength, V_j, can be predicted using the following equation:

$$V_j = K \; \zeta \; f_c' \; b_j \; a_s \cos\theta \tag{2-8}$$

where b_j is the effective joint width; a_s is the depth of the compression strut; K is the strut-and-tie index; ζ is the softening coefficient; f_c' is the compressive strength of a standard concrete cylinder; and θ is the angle of strut inclination to the horizontal axis and defined as

$$\theta = \tan^{-1}\left(\frac{\ell_v}{\ell_h}\right) \tag{2-9}$$

where ℓ_v and ℓ_h is defined as the distance between extreme longitudinal reinforcement in beam and in column, respectively. Meanwhile, the effective joint width is redefined for the eccentric beam-column joint.

Due to the presence of joint reinforcement and intermediate column bars which act as tension ties, more concrete is activated to resist shear strain. A factor representing this beneficial effect in the shear strength is given by the strut-and-tie index, K (Hwang and Lee 2002):

$$K = K_h + K_v - 1 \tag{2-10}$$

where K_h and K_v are the horizontal and vertical tie indices:

$$K_h = 1 + \frac{\left(\overline{K}_h - 1\right) A_{th} f_{yh}}{\overline{F_h}} \le \overline{K}_h \tag{2-11a}$$

$$K_v = 1 + \frac{\left(\overline{K}_v - 1\right) A_{tv} f_{yv}}{\overline{F_v}} \le \overline{K}_v \tag{2-11b}$$

Here, A_{th} and A_{tv} are the areas of the horizontal ties and column intermediate bars within the effective joint width, respectively (detailed information on determination of A_{th} and A_{tv} can be found in Hwang and Lee (1999) and (2000)) ; f_{yh} and f_{yv} represent the yield strength of the horizontal ties and the column intermediate bars, respectively; $\overline{K}_h$ and $\overline{K}_v$ are the horizontal and vertical tie index with sufficient horizontal and vertical reinforcement which are estimated to be:

$$\overline{K}_h \approx \frac{1}{1 - 0.2(\gamma_h + \gamma_h^2)} \tag{2-12a}$$

$$\overline{K}_v \approx \frac{1}{1 - 0.2(\gamma_v + \gamma_v^2)} \tag{2-12b}$$

where γ_h is the fraction of horizontal shear transferred by horizontal ties in the absence of intermediate vertical column bars. Also, γ_v is the fraction of vertical shear transferred by the intermediate vertical column bars in the absence of the horizontal ties such that:

$$\gamma_h = \frac{2\tan\theta - 1}{3} \quad \text{for} \quad 0 \le \gamma_h \le 1 \tag{2-13a}$$

$$\gamma_v = \frac{2\cot\theta - 1}{3} \quad \text{for} \quad 0 \le \gamma_v \le 1 \tag{2-13b}$$

Here, $\overline{F}_h$ and $\overline{F}_v$ are the balanced amount of the horizontal tie force and the column intermediate bar force, respectively:

$$\overline{F}_h = \gamma_h \times (\overline{K}_h \zeta\, f_c'\, b_j\, a_s) \times \cos\theta \tag{2-14a}$$

$$\overline{F}_v = \gamma_v \times (\overline{K}_v \zeta\, f_c'\, b_j\, a_s) \times \sin\theta \tag{2-14b}$$

Fig. 2-7b describes the strain compatibility satisfied by a softened-strut-and-tie model. The first strain invariant satisfies Mohr's two dimensional compatibility as given :

$$\varepsilon_h + \varepsilon_v = \varepsilon_r + \varepsilon_d \tag{2-15}$$

where ε_d and ε_r are average normal strains in d- and r- directions, respectively and ε_v and ε_h are average normal strains in v- and h- directions, respectively.

The constitutive laws satisfied by this model adopts from softened reinforced concrete stress-strain curve suggested by Zhang and Hsu (1993). The ascending branch of the softened reinforced concrete stress-strain curve is:

$$\sigma_d = -\zeta\, f_c' \left[2\left(\frac{-\varepsilon_d}{\zeta\varepsilon_0}\right) - \left(\frac{-\varepsilon_d}{\zeta\varepsilon_0}\right)^2 \right] \quad \text{for} \quad \frac{-\varepsilon_d}{\zeta\varepsilon_0} \le 1 \tag{2-16a}$$

where σ_d is the average normal stress in the d-direction, negative for compression, the softening coefficient, ζ, is defined as

$$\zeta = \frac{5.8}{\sqrt{f_c'}} \frac{1}{\sqrt{1+400\varepsilon_r}} \le \frac{0.9}{\sqrt{1+400\varepsilon_r}} \tag{2-16b}$$

and ε_0 is the strain at the peak stress of a standard concrete cylinder as determined in Eq. (2-17) (Foster and Gilbert 1996).

$$\varepsilon_0 = 0.002 + 0.001\left(\frac{f_c' - 20}{80}\right) \quad \text{for} \quad 20 \le f_c' \le 100\text{MPa} \tag{2-17}$$

Furthermore, the softening coefficient, ζ, was simplified by assigning the horizontal ties and vertical column intermediate bar strain to be the yielding strain of steel ($\varepsilon_h = \varepsilon_v = 0.002$) and the average diagonal compressive strain in the d-direction as $\varepsilon_d = -0.001$ (Hwang and Lee 2002). Hence, the principal tensile strain, ε_r, can be calculated using Eq. (2-15). By assigning the pre-determined principal tensile strain, ε_r = 0.005 to Eq. (2-16b), we have:

$$\zeta \approx \frac{3.35}{\sqrt{f_c'}} \leq 0.52 \tag{2-18}$$

CHAPTER III

BEAM-COLUMN JOINT DATABASE

In order to support the analytical model proposed, then a collection of previous research result is needed for the verification. In this thesis, the systematical storage of experimental study on test of joints is performed. As many as 18 beam-column joints with eccentricity (Table A1), 52 concentrically connected interior joints (Table A2), and 56 concentrically connected exterior joints (Table A3) are collected from available literatures. There are six major components in tests of every joint which are recorded in this work, i.e. column, main beam, transverse beam, slab, joint, and load-deflection backbone curve. The general notations for overall 3-dimensional joint geometry confined in four sides and with the presence of slab as well as the coordinate convention being used are shown in Fig. 3-1. For 2-dimensional joints or exterior joints, the irrelevant information is simply deleted. Appendix A shows all the stored information related to a joint specimen. Detailed storage system of collected research data will be described in the following sections.

3.1 Column

A typical beam-column joint assemblage usually takes the free body at the mid-height (point of inflection) of upper column and lower column. Fig. 3-2 shows the typical side view of 2-D interior joints. The recorded column parameters (Appendix A) are:

- Column dimension
    - Length of upper column (L_column_u) and lower column (L_column_lw) as depicted in Fig. 3-1. The total length of upper and lower column reflects the original inter-storey height in buildings.
    - Size of column cross section, b_c and h_c (Fig. 3-3a)
    - Concrete cover, measured from the free edge to center of outer-most column longitudinal bar, in x- and y- direction
    - Concrete compression strength, f_c' in the upper and lower column

- Column longitudinal bars
    - The size variation of longitudinal bars is provided for the corner, side, and intermediate bars (Fig. 3-3a)
    - Location of each layer of longitudinal bar is defined in Fig. 3-3a
    - Tensile yielding strength, f_y of column longitudinal bars may also be input as the size of bar changes
- Column transverse reinforcement
    - Geometry of transverse reinforcement is divided into several types as

indicated in Fig. 3-4.

- For each transverse reinforcement, depending on its type, the size and number of legs provided may also be input accordingly in Appendix A. Also, the area of each layer of transverse reinforcement, A_{sh} in x- and y- direction is also shown in Appendix A.
- Vertical spacing of column transverse reinforcement may differ along the column length. To capture this detailing, each column (upper column and lower column) is divided into two sections, first and second section (Fig. 3-2).
- Tensile yielding strength, f_y of transverse reinforcement can also be input accordingly in Appendix A.

3.2 Main Beam

Fig. 3-2 shows the typical side view of 2-D interior joints. The recorded beam parameters are:

- Main beam dimension
  - Length of left side (L_beam_l) and right side of beams (L_beam_r).
  - Size of beam cross section, b_b and h_b (Fig. 3-3b)
  - Concrete cover, measured from the free edge to center of outer-most beam

longitudinal bar, in x- and y- direction.

  - Concrete compression strength, f_c' in the left and right beam.

- Main beam longitudinal bars
  - The size variation of longitudinal bars is provided for the corner, intermediate, inner, and side bars (Fig. 3-3b)
  - Location of each layer of longitudinal bar is defined as shown in Fig. 3-3b
  - Tensile yielding strength, f_y of beam longitudinal bars may also be input as the size of bar changes
- Main beam transverse reinforcement
  - Typical beam transverse reinforcement may not be as various as that of column's. Hence, in the data storage system, the beam transverse reinforcement is considered as common closed stirrup (2 legs) with or without additional vertical ties.
  - For each transverse reinforcement, the size of stirrup and vertical tie may differ. However, the number of legs for stirrup is set to be two, meanwhile the number of legs of vertical ties may be input accordingly.
  - Horizontal spacing of beam transverse reinforcement may differ along the beam length. To capture this detailing, each beam (left and right beam) is

divided into two sections, first and second section (Fig. 3-2).

- Tensile yielding strength, f_y of transverse reinforcement can also be input accordingly in Appendix A. But, no distinction is made for stirrup and vertical tie.

3.3 Joint

Fig. 3-2 shows the typical side view of 2-D interior joints. The recorded column parameters are:

- Joint dimension
  - Although size of joint is the same with that of column's, for completeness, the joint width (taken to be equal to column width), joint depth (taken to be equal to column depth), and joint height (h_{jt}), measured between the outer most reinforcement of main beam longitudinal bars, are kept in Appendix A.
- Joint longitudinal bars
  - Joint longitudinal bars are the same as those in column and therefore not repeated anymore.
- Joint transverse reinforcement
  - Similar to column transverse reinforcement, joint transverse reinforcement is

also divided into several types as indicated in Fig. 3-4.

- For each transverse reinforcement, depending on its type, the size and number of legs provided may also be input accordingly. Also, the area of each layer of transverse reinforcement in x- and y- direction are also computed. In addition to that, the number of joint reinforcement layer along the joint height is also documented.
- Vertical spacing of column transverse reinforcement.
- Tensile yielding strength, f_y of transverse reinforcement.
- The ACI 318-08 code provision for minimum required area of joint transverse reinforcement is also computed for x- and y- direction using

$$A_{sh} = 0.3sh_c \frac{f_c'}{f_y}\left(\frac{A_g}{A_{ch}} - 1\right) \tag{3-1}$$

$$A_{sh} = 0.09sh_c \frac{f_c'}{f_y} \tag{3-2}$$

3.4 Transverse beam

As shown in Fig. 3-1, transverse beams are beams framing in a perpendicular direction to the (main) beam. Fig. 3-5(a) shows the relative position of transverse beam to the intersection of main beam and column. The data to be stored for transverse beams are:

- Transverse beam dimension
  - Length of north (L_tb_n) and south side (L_tb_s) of transverse beams (Fig. 3-1).
  - Size of transverse beam cross section, b_{tb} and h_{tb} (Fig. 3-5b).
  - Concrete cover, measured from the free edge to center of outer-most transverse beam longitudinal bar, in x- and y- direction.
  - Concrete compression strength, f_c' in for transverse beam.
- Transverse beam longitudinal bars
  - The size variation of longitudinal bars is provided for the corner, inner, and side bars (Fig. 3-5b)
  - Location of each layer of longitudinal bar is defined as shown in Fig. 3-5b
  - Tensile yielding strength, f_y of transverse beam longitudinal bars may also be input as the size of bar changes
- Beam transverse reinforcement
  - Typical beam transverse reinforcement may only be reinforced similar to main beam. Hence, in the data storage system (Appendix A), the beam transverse reinforcement is considered as common closed stirrup (2 legs) with or without additional vertical ties.

- For each transverse reinforcement, the size of stirrup and vertical tie(s) may differ. However, the number of legs for stirrup is set to be two, meanwhile the number of leg of vertical tie may be input accordingly.
- Horizontal spacing of beam transverse reinforcement is considered to be the same along the transverse beam.
- Tensile yielding strength, f_y of transverse reinforcement can also be input accordingly in Appendix A. But, no distinction is made for stirrup and vertical tie.

3.5 Slab

In the ordinary reinforced concrete frame buildings, it is rarely seen to have beam-column joints without any presence of slab. As shown in Fig. 3-1, a general assemblage of beam-column joint with slab, the data to be stored for slab are:

- Slab dimension
  - Length of slabs, in four possibly considered direction (L_slab_n, L_slab_s, L_slab_l, and L_slab_r) (Fig. 3-1)
  - Slab thickness, h_s (Fig. 3-5b).
  - Concrete compression strength, f_c'.

- Slab reinforcement bars
    - The size variation of longitudinal bars is provided for the slab reinforcement in x- and y- direction for top and bottom sides (Fig. 3-5b)
    - The spacing of slab reinforcement may be input accordingly.
    - Tensile yielding strength, f_y of slab reinforcement may also be input as the size of bar changes

3.6 Load-deflection backbone curve

The joint test setup may allow the force to be input in four different ways, referred here as Type I, II, III, and IV (Fig. 3-6)

The load-deflection backbone curve is stored at the 0.5%, 1.0%, 2.0%, 3.0%, and 4.0% drift ratio for positive and negative direction, also the maximum loading and its corresponding drift ratio.

3.7 Database characteristics

This section describes the overall characteristics of the collected tests for both concentric and eccentric, exterior and interior beam-column joints.

For concentric beam-column joints, as many as 108 specimens are collected based on researches conducted worldwide. Fifty two of them are regrouped as interior joints and the rest 56 joints are grouped as exterior joints (Fig. 3-7a). Among the 52 interior joints, 9 of them are confined with transverse beam either on one side or on both sides, with or without slabs. And another 43 specimens are simple cruciform-type interior joints. Meanwhile, among the 56 collected exterior joints, 10 of them are confined with transverse beam either on one side or on both sides, and the rest 46 are simply T-shape exterior joints. Fig. 3-7b shows the geometry of collected eccentric beam-column joint specimens. As many as 18 specimens are collected. Two of them are grouped as interior joint specimens with transverse beam, another 14 specimens are simple interior joints without transverse beam (cruciform-shape), and the rest 2 specimens are grouped as exterior joints without transverse beam (T-shape).

Figure 3-8, 3-9, and 3-10 further show the distribution of available joint specimens based on several key parameters, such as concrete compressive strength, axial load ratio, and ratio of column to beam width.

Figure 3-8 shows the database characteristics for 56 exterior joints. Figure 3-8a shows that about 33 specimens are considered using normal strength concrete (< 50 MPa). Meanwhile, other 23 specimens were tested using high strength concrete (> 50 MPa). Figure 3-8b describes that almost all joints were tested under low axial load condition. Figure 3-8c shows that most of the joints do not have wide column and narrow beam effect, but one specimen (W0). This specimen with ratio of column to beam width equals to 2.0 were tested by Lee and Ko (2007).

Database characteristics for interior joints are shown in Fig. 3-9. The distribution of the use of normal strength concrete is more various in the tests of interior joints. Only one specimen were tested using high strength concrete (> 50 MPa) as shown in Fig. 3-9a. The distribution of applied axial load ratio is shown in Fig. 3-9b. About half of the specimens were tested under low axial load condition, and another half were tested under moderate to high axial load ratio condition. Effect of wide column and narrow beam are not shown clearly in interior joint databases (Fig. 3-9c).

Figure 3-10 shows the distribution of eccentric joint databases collected. As shown in Fig. 3-10a, all of the eccentric joints were tested using normal high strength concrete. The applied axial load ratio is also considered to be low (Fig. 3-10b). Meanwhile, the effect of wide column and narrow beam may be clearer as shown in Fig. 3-10c.

Another parameter to describe the characteristics of joints database is as shown in Fig. 3-11. As has been acknowledged, ACI 318-08 design equation follows exactly recommendation from ACI 352R-02 for type II joints, except for the definitions on effective joint width. Type II joints are joints designed to resist earthquake in high seismic are, where not only strength is important, but also the deformation ductility. In other words, ACI 318-08 design equation is aimed to predict shear strength of joints failed under ductile behavior.

Another parameter being used to describe the completeness of joint database is through the behavior of specimens described from the joint failure mode. Based on joint failure mode, the joints database can divided into three categories, i.e.: BF (failure occur at beam, joint is still intact), BJ (joint fails in shear, framing beams reach yielding), and J(joint fails in shear, but framing beams do not reach yielding). Fig. 3-11 shows that for joints failing in BF type, the ACI 318-08 strength prediction is far larger that the tested value. This category does not reflect the joint strength, rather, it only describes that the BF type joint fail before the joint shear capacity is reached. For BJ type joints, the ACI 318-08 strength estimation is at its most accurate, because this type of joint is what ACI 318-08 design equation aims for. Meanwhile the ACI 318-08 design equation underestimate J type joints, because these joints fail at much higher value with less ductility. Hence, base on Fig. 3-11, it is concluded that the specimens collected in database reflects all the possible joint failure criteria.

CHAPTER IV

SOFTENED STRUT-AND-TIE MODEL FOR ECCENTRIC JOINTS

As has been explained previously, the current design equation adopted in several building codes to estimate join shear strength is based on the average shear stress by limiting the effective joint width, which is determined empirically. This chapter, with the basis of softened strut-and-tie model, derives the determination of effective joint width. In order to give full understanding as well as to examine the sensitivity of SST analysis, three tiers of analysis are further introduced to estimate the collected 18 specimens of eccentric beam-column joints using the derived effective joint width.

4.1 Derivation of effective joint width and depth of strut

In the previous developed softened strut-and-tie model for concentric joints, the effective joint width can always be taken as the whole column width (Hwang and Lee 1999, 2000). However, the same condition does not apply when eccentricity exists between the centre of the column and the longitudinal axis of the beam. The determination of the effective joint width is sensitive to the geometric constraints provided by the framing beams outside the joint core.

For a typical interior joint with slab, the lower end of the diagonal compressive strut is only confined by the compression zone of the beam web while the upper end is confined by both the beam and the slab (Fig. 4). Hence, the strut area, which is defined as the product of effective joint width and depth of compression strut, is much smaller at the lower end (without the presence of slab) and therefore governs the strength.

The effective joint width defined at the lower end is determined as follows: by firstly taking the failure criteria of SST model to be the crushing of strut area adjacent to the nodal zone, hence the effective joint width should be determined at the location of concrete crushing, which is taken to be at the resultant of column compressive stress. The joint width is originally assumed to be as wide as beam width, b_b, at the beam-column interface. As the compression stress of beam spreads out into the joint zone with a certain slope, the effective joint width also gets wider accordingly and ends at the location of crushing. Because most of the specimens were designed following strong column weak beam philosophy, so the column is still in elastic range when the maximum joint capacity is attained. Hence, the resultant of column compression strength can be taken at one-third of depth of column compression zone ($c_c/3$). Meanwhile, the slope of stress dispersion is taken to be 1:2, following the ACI

318-08 recommendation for calculating the bearing strength. Finally, the effective joint width can be written as given:

$$b_j = b_b + \sum \min\left(2 \times \frac{c_c}{3}; x_i\right) \tag{4-1}$$

where b_b is width of the beam; c_c is the depth of column compression zone; and x_i is the perpendicular distance from the longitudinal axis of the beam to the column side.

In this thesis, the depth of strut, a_s is also redefined. Previously, the depth of strut was simply taken as the hypotenuse of compression zone contributed from column and beam as shown in Eq. (4-2) (Hwang and Lee 1999, 2000)

$$a_s = \sqrt{c_b^2 + c_c^2} \tag{4-2}$$

where c_c is the depth of column compression zone, and c_b is the depth of beam compression zone. Here, according to ACI 318-08, the depth of strut is taken to be perpendicular to the angle of inclination, θ. Hence, the depth of strut is taken as (Fig. 4-2b)

$$a_s = c_c \sin\theta + c_b \cos\theta \tag{4-3}$$

4.2 Test verifications for eccentric joints using SST analysis

A total of 18 specimens of eccentric beam column joints (Table 4-1) are collected from Joh et al (1991), Raffaelle and Wight (1995), Teng and Zhou (2003), Shin and LaFave (2004), Goto and Joh (2004), Kusuhara et al. (2004), and Lee and Ko (2007). All of the selected specimens failed in shear. Meanwhile, geometrically, two of them are joints with slabs (Specimen S1 and S2), another three are T-shape joints (Specimen S50, W75, and W 150) , and the other fourteen specimens are cruciform-type joints. The provided joint transverse reinforcement is as indicated in Table 4-1

The originally derived SST model (Hwang and Lee 1999, 2000) was a complete solution procedure (termed as SST general approach). However, this solution procedure was tedious and impractical for design practice. Therefore, a simplified version (termed as simplified SST approach) was introduced to serve as design tool for determining the shear strength of discontinuity regions failing in diagonal compressions (Hwang and Lee 2002). Since SST model assumes failure at the compression strut adjacent to the nodal zone, hence the determination of the strut area is very important and sensitive to the end condition provided by the framing members of beam-column joints, especially the depth of beam and column compression zone.

Therefore, in the shear strength prediction for eccentric beam-column joints using the SST model, three tiers of analysis (referred to as Analysis 1, 2, and 3) in terms of the sophistication of SST solution procedure and the accuracy of determination of the depth of the beam and column compression zone (Analysis 1 being the simplest and Analysis 3 being the most sophisticated) are performed. Analysis 1 and Analysis 2 predict the joint strength by using a simplified SST approach (Hwang and Lee 2002) while Analysis 3 uses a general SST approach (Hwang and Lee 1999, 2000).In determining the column depth of the compression zone, c_c, Analysis 1 adopts the empirical formula proposed by Paulay and Priestley (1992)

$$c_c = \left(0.25 + 0.85 \frac{N}{A_g f_c'} \right) h_c \tag{4-4}$$

where N is the column axial load, A_g is the gross area of the column section, and h_c is the depth of the column. Furthermore, the beam depth of the compression zone, c_b, is calculated using Whitney's stress block by simply neglecting the beam compression bars so that:

$$c_b = \frac{A_s f_y}{\beta_1 0.85 f_c' b_b} \tag{4-5}$$

where A_s is the area of the tensile beam longitudinal reinforcement bars, f_y, is the yield strength of longitudinal reinforcement bars (rebars), and β_1 is a factor relating the depth of equivalent rectangular compressive stress block to the neutral axis depth. On the other hand, for Analysis 2 and Analysis 3, the depths of the compression zones of beams and columns are obtained using sectional analysis at the maximum response of joint resistance in order to get more accurate values. Due to the bond deterioration, the compression rebars in the beam may not reach the yielding strength. As suggested by the New Zealand Standard (1995), the maximum attained stress of the compression rebars should not exceed $0.7 f_y$. However, some joint specimens with eccentricity do not possess adequate joint confinement as required by

ACI 318-08 (Table 1). This inadequacy is realized to create more severe bond deterioration compared to that anticipated by New Zealand Standard (NZS 3101:1995), therefore, in this research, the value of $0.5f_y$ is used. Further parameters and the predicted values of each analysis are shown in Table 4-2. More detailed calculation example is provided in Appendix B.

Table 4-3 shows the strength ratios of the test values to the predicted values. Analysis 1 gives a mean value of 1.60 and a coefficient of variation (COV) of 0.28. Analysis 2 gives 1.34 and 0.22 for the mean value and COV, respectively. Analysis 3 results in 1.29 for the mean value and 0.19 for the COV. It is clearly seen that the accuracy of the analysis tool is getting better as the more refined approach is used. Moreover, it is also observed that the determination of strut area (and correspondingly, the determination of depth of beam and column compression zone) plays a more significant effect compared to the solution procedure itself. However, for the T-shape joints tested by Lee and Ko (2007), the SST predicts greater strengths than what is observed. Although it is an analytical model, several assumptions were still needed. Hence, the applicability of SST analysis in predicting joint shear strength of eccentric beam-column joints should be limited by the experimental parameters, such as: maximum axial load ratio, $N/A_g f_c' < 0.17$, eccentricity, $e/b_c \leq 0.3$, and column aspect ratio, $b_c/h_c \leq 2.0$ (as indicated in Table 4-1)

CHAPTER V

DESIGN IMPLEMENTATION

It is has been pointed out and realized that an analytical model for predicting joint horizontal shear strength is necessary. From the previous chapter analysis, the strength predictions using softened strut-and-tie model and the newly proposed effective joint width (Eq. 4-1) shows a good agreement with test results. However, for the design purpose, the SST procedural analysis is still too tedious.

The current design approach adopted using average shear stress concept has been used widely. Therefore, it is considered worthwhile to simplify the proposed effective joint width to be compatible with average shear stress concept.

Hence, the first section of this chapter will derive the simplification equation for proposed effective joint width. The proposed equation for effective joint width, used together with ACI 318-08 code equation for predicting joint strength, is then used to verify the test results of collected database for both concentric and eccentric joints. Some sensitivity analysis and justification with regard to several assumptions are performed.

5.1 Simplification of proposed effective joint width

As has been prescribed previously, the proposed effective joint width which is derived associated with the softened strut-and-tie model (Eq. 4-1) is further simplified to be compatible with ACI 318-08 code equation (Eq. 2-2).

In common buildings, it is rational to take axial load ratio $N/A_g f_c'$ as 0.15. By substituting this value into Eq. (4-4), the depth of the compression zone can be obtained:

$$c_c = (0.25 + 0.85 \times 0.15)h_c = 0.377 h_c \tag{5-1}$$

Further substitution of Eq. (5-1) into Eq. (4-1) yields the proposed effective joint width such that:

$$b_{j,proposed} = b_b + \sum \min\left(\frac{h_c}{4}; x_i\right) \tag{5-2}$$

Hereafter, Eq. 5-2 is called the proposed effective joint width.

The applicability of proposed effective joint width with the ACI 318-08 code design formula is verified in the following sections to check its performance when being used for eccentric joints and its consistency for concentric joints.

5.2 Test verification for concentric exterior joints

Complete information regarding the concentric exterior joint databases can be found in Appendix A (Table A2). However, for ease of analysis, several key parameters are shown in

Table 5-1.

Table 5-2 shows the failure modes and strength ratio of exterior joints when calculating using

$$V_j = 0.083\gamma\sqrt{f_c'}b_j h_c \qquad (2\text{-}2)$$

Meanwhile, the effective joint widths being used are as proposed in ACI 318-08, ACI 352R-02, and the currently proposed effective joint width (Eq. 5-2).

Table 5-2 shows the strength ratios between test values and predicted values using Eq. (2-2) but with different definitions of effective joint width for all collected concentrically connected exterior joints database. To get the whole picture of the accuracy of each effective joint width definition, only specimens failed in joint shear (BJ and J) will be accounted for calculating the mean value. The mean value of calculated statistical data for exterior joints failing in joint shear (BJ and J) for ACI 318-08, ACI 352-02, and proposed effective joint width are 0.89, 0.97 and 0.89 respectively with the same coefficient of variation (COV), that is 0.17. These results indicate that the current design equation with three different effective joint widths still results in unconservative results. This phenomena has also been acknowledged by Ehsani and Wight (1985) and ACI 318-08 commentary. With regard to the unconservatism of ACI 318-08 design equation in predicting shear strength of exterior joints, it is also interesting to note the recommendation from AIJ Guideline (1999). ACI 318-08 and

AIJ Guideline (1999) adopt direct strut mechanism, rather than truss mechanism as the main resisting mechanism in beam-column joint. For exterior joints, AIJ Guideline (1999) recommends that the diagonal strut start at the corner of the bend of 90-degree hook, therefore, the horizontally projected length of the 90-degree hook, rather than the whole column depth is used as the joint depth (see Appendix C)

In addition to that, the proposed effective joint width gives the same accuracy as that given by ACI 318-08 equation because the whole column width governs. Meanwhile, ACI 352R-02 gives lower strength estimation about 10% compared to ACI 318-08 and proposed effective joint width, because the average of column and beam width is used instead of whole column width. Here, the 10% conservatism is considered unnecessary, because the ACI 318-08 equation has been long adopted since 1989 and worked well so far.

It is worthwhile to note that one specimen tested by Lee and Ko (2007), i.e. specimen W0, because the ratio of column to beam width equals to 2.0, therefore, the proposed effective joint width gives a lower estimation (on more conservative side) in this case. In this particular case, it is considered that the proposed effective joint width may serve well for wide column narrow beam joint issue.

Meanwhile, a more detailed analysis is conducted by separating the specimens based on their failure modes. Failure mode BF means the specimens failed in beam hinging, failure mode BJ means the specimens failed in joint shear after yielding of beams, and failure mode J means that the specimens failed in joint shear before beam yielding (Fig. 5-1). The analysis shows that the strength ratio is getting larger as the joint failure mode shift from BF type to BJ type and J type. This tendency can be explained as follows: The purpose of ACI 318-08 design equation is for beam-column joints in areas with high seismic risk, where strength and deformation capacity are important. Consequently, this design equation shoots for joints with BF (beam failure, joint is still in intact condition) or BJ (joint shear failure with high ductility after beam hinging) type failure mode. Therefore, for joints failing in J type mode (correspondingly with a higher shear strength), the strength ratio between the test value to the predicted value using ACI 318-08 equation is increasing accordingly.

5.3 Test verification for concentric interior joints

Table 5-3 shows the key specimen parameters extracted from the joint databases in Appendix A. The specimens are then used to verify the accuracy of effective joint width as given in ACI 318-08, ACI 352R-02, and proposed effective joint width using ACI 318-08 design equation (Eq. 2-2). The calculated results and the strength ratios between test values to predicted values are given in Table 5-4. In order to get better picture on the accuracy of each definition of effective joint width, only specimens failed in joint shear (BJ and J) are considered in calculating the mean value and coefficient of variation. The mean value obtained from ACI 318-08, ACI 352R-02, and proposed effective joint width definition are 1.12, 1.24, and 1.12, respectively, with COVs equal 0.22 for all three methods. Again, this indicates that the proposed effective joint width (Eq. 5-2) preserves the accuracy currently adopted by ACI 318-08 equation for joint width (Eq. 2-4a and Eq. 2-4b).

Similar to the treatment with exterior joints, Fig. 5-2 shows the plotting of strength ratio by separating the failure mode as BF, BJ, and J as indicated above. The strength ratio gives a higher value as the change of failure mode from BF to BJ and J type.

5.4 Test verification for eccentric joints

The same procedure of analysis is also applied to eccentric joints (Table 5-5). The statistical data of mean value for each equation shows that the ACI 318-08's effective joint width gives the most conservative result, i.e. 1.51, followed by ACI 352R-02, i.e. 1.30. Meanwhile, the accuracy of the proposed effective joint width and that suggested by LaFave et al. (2005) gives approximately same result. In addition to that, the data dispersion as indicated COV shows that all approaches have approximately the same results. The relevant plot is shown in Fig. 5-3. This result suggests that the proposed effective joint width can well predict the shear strength of eccentric joints with reasonable accuracy. Some larger strength ratios (i.e. UM-60, UM-125, UU-125) are due to the failure mode governing those specimens. The three mentioned specimens (UM-60, UM-125, and UU-125) all failed in joint shear without beam yielding, therefore the ACI 318-08 design equation underestimate the joint strength.

5.5 Sensitivity Analysis

It is realized that some sensitivity analysis are needed in this research work to justify the adopted assumptions. Two main concerns are the justification on use of Paulay and Priestley equation (Eq. 4-4) together with axial load ratio ($N/A_g f_c'$) to be 0.15 and the other one is the sensitivity of proposed effective joint width related to the currently available definitions on effective joint width. Two of these analyses are presented as follows:

Sensitivity analysis on Paulay and Priestley Equation

In this research work, several assumptions were made in deriving the proposed effective joint width (Eq. 5-2). Two of the most significant assumptions is the using of Paulay and Priestley (Eq. 4-4) and the use of 0.15 to be the axial load ratio ($N/A_g f_c' = 0.15$). As has been explained before, Eq.4-4 is used because all of the collected joint specimens were designed based on strong column weak beam philosophy. Hence, when reaching the maximum joint strength capacity, most of the columns were still in elastic range. Meanwhile, the use of axial load ratio equals 0.15 ($N/A_g f_c' = 0.15$) is for the sake of conservatism. The combination of these two assumptions results in the proposed effective joint width (Eq. 5-2) which not only can give good strength prediction for eccentric joints, but also preserve the accuracy of currently adopted ACI 318-08 definition of effective joint width and address the issue of wide column narrow beam joint well.

However, there was no sensitivity analysis done so far to describe the relations between these two. Therefore, in this thesis the sensitivity analysis is performed and shown in Fig.5-4.

Two types of column dimensions are used, i.e.: columns with 20”×20” and 40”×40”. Each of these columns is also reinforced with two kind of different reinforcement ratio (ρ), i.e.: $\rho = 3\%$ and $\rho = 4\%$. Finally, with a varying axial load ratio being the initial loading, all of these column sections are analyzed to obtain the depth of column compression zone at two critical stages, i.e.: at first yielding ($\varepsilon_y = 0.002$) and at nominal moment strength ($\varepsilon_c = 0.003$).

The analysis (Fig. 5-4) shows that Eq. 4-4 gives conservative estimation for depth of compression zone for columns in elastic range when subjected to low axial load ratio ($N/A_g f_c' \leq 0.25$), while may be unconservative once the columns reach their nominal moment strength. Based on this analysis, it is justified that the use of Eq. 4-4 together with

$N/A_g f_c' = 0.15$ in deriving proposed effective joint width (Eq. 5-2) still give conservative results for available collected database (in database, all of the columns are still in elastic when joint reach maximum strength).

Sensitivity analysis of proposed effective joint width

One of the research objectives is to solve the wide column and narrow beam joint effect. This type of joint may be found in high rise buildings and it may get worse as the use of high strength materials which enable a significant reduction in beam size, meanwhile due to performance criteria, the column size may not be reduced significantly.

Based on the analysis given above, it is expected that the proposed effective joint width can work well with for wide columns and narrow beam effect. So, it is interesting to examine the characteristics of this proposed effective joint width compared to currently available definitions for effective joint width as adopted in ACI 318-08 and ACI 352R-02.

Three types of columns are examined with regard to this analysis, i.e.: rectangular columns subjected to loading in the strong axis with column aspect ratio ($h_c/b_c = 2.0$), square columns ($h_c/b_c = 1.0$), and rectangular columns subjected to loading in weak axis ($h_c/b_c = 0.5$) as can be seen in Fig. 5-5. By varying the ratio of column width and beam width (b_c/b_b), the lines are plotted to show the ratio between effective joint width to beam width (b_j/b_b). The effective joint width considered are based on ACI 318-08 definition, ACI

352R-02, and proposed effective joint width.

The analysis shows that ACI 318-08 definition for effective joint width always result in biggest value compared to other two. Meanwhile, ACI 352R-02 always gives the lowest estimation for effective joint width. In these figures, it can be concluded that the proposed effective joint width can be flexible in use for typical column dimension or wide column narrow beam joints. However, because of the limited research data, this conclusion is still not mature enough and may be further studied.

CHAPTER VI

CONCLUSIONS

The research conducted in this master thesis primarily aims to predict the horizontal shear strength of eccentric beam-column joints using a more analytical approach, i.e. softened strut-and-tie (SST) model. This SST model is further developed by refining the definition of effective joint width. The analytically derived effective joint width associated with SST failure criteria is then simplified to accommodate the use in current ACI 318-08 design equation for predicting joint shear strength. In order to examine the performance of SST model and proposed effective joint width, test verifications on 18 eccentric beam-column joint specimens are performed. Meanwhile, to maintain the accuracy of newly proposed effective joint width with the current ACI 318-08 formulas for joint width, test verifications on 52 specimens of concentrically connected interior joints and 56 specimens of concentrically connected exterior joints are performed. And finally, some simple parametric investigations are conducted.

Based on the above summary, the following conclusions are drawn:

1. The analytically derived effective joint width associated with the softened strut-and-tie (SST) model has been proposed.

2. Three tiers of SST analysis, with each tier of analysis uses a more refined approach of SST model (in terms of sophistication of solution procedure and determination of beam and column depth of compression zones) together with the derived effective joint width agree well with test values of eccentrically connected beam-column joints and still on a more conservative side. However, the applicability is still limited to several test parameters as discussed.
3. The analytically derived effective joint width is further simplified to accommodate the use of current ACI 318-08 design formula. Several available definitions on effective joint width are also used as comparison with the proposed one.
4. Using the ACI 318-08 design equation, the effective joint width definition given by LaFave et al. is the best, followed by the proposed effective joint width. Meanwhile, ACI 318-08 definition gives the most conservative result.
5. The analytically derived effective joint width gives the same accuracy and coefficient of variation of the strength ratio as that given by ACI 318-08. Meanwhile, ACI 352R-02 gives a 10% lower estimation, which is considered unnecessary.
6. Sensitivity analysis on Paulay and Priestley equation shows that this equation provides smaller depth of compression zone for elastic column under low axial load ratio.
7. Sensitivity analysis on the characteristics of proposed effective joint width with ACI

318-08 and ACI 352R-02 definition for effective joint width shows that the proposed one can work well for typical column dimension and wide column narrow beam joints.

NOTATION

a_s = depth of compression strut

A_{ch} = core area of column, measured between outer most hoop

A_g = gross area of column or beam section

A_{sh} = total cross-sectional area of transverse reinforcement (including crossties) within spacing s and perpendicular to dimension b_c

A_{th}, A_{tv} = area of horizontal ties and column intermediate bars, respectively

b_b = width of beam

b_c = width of column

b_j = effective joint width

$b_{j,ACI\ 318-08}$ = effective joint width per ACI 318-08 definition

$b_{j,ACI\ 352-02}$ = effective joint width per ACI 352R-02 definition

$b_{j,proposed}$ = proposed effective joint width

b_{tb} = width of transverse beam

C_c, C_c' = compressive force from beam

C_d = diagonal compressive strength

C_s, C_s' = compression force from beam reinforcement bars

D = compressive force in diagonal strut

e = eccentricity between the beam centerline to column centerline

E_s = steel modulus of elasticity

f_c' = compressive strength of standard concrete cylinder

$f_{yh},\ f_{yv}$ = yield strength of the horizontal ties and column intermediate bars, respectively

F_h, F_v = horizontal and vertical tie force, respectively

F_{yh}, F_{yv} = yielding forces of the horizontal ties and column intermediate bars, respectively

$\overline{F}_h, \overline{F}_v$ = balanced amount of horizontal tie force and vertical column intermediate bar force, respectively

h_b = depth of main beam

h_c = depth of column

h_{jt} = height of joint

h_{tb} = depth of transverse beam

K = strut-and-tie index

K_h, K_v = horizontal and vertical tie index, respectively

$\overline{K}_h, \overline{K}_v$ = horizontal and vertical tie index with sufficient horizontal or vertical reinforcement, respectively

ℓ_h, ℓ_v = distance between extreme longitudinal bars in column and beam, respectively

N = column axial load

T, T' = Tension force from beam reinforcement bars

V_j = joint shear strength

x = perpendicular distance from longitudinal axis of beam to column side

β_1 = factor relating depth of equivalent rectangular compressive stress block to neutral axis

ε_0 = strain at peak stress of standard concrete cylinder

$\varepsilon_d, \varepsilon_r$ = average normal strains in d- and r- directions, respectively

$\varepsilon_v, \varepsilon_h$ = average normal strains in the v- and h- directions, respectively

γ = constant to account for the confinement effect provided by framing beams

γ_h = fraction of horizontal shear transferred by horizontal tie with absence of vertical column intermediate bar

γ_v = fraction of vertical shear transferred by vertical column bar with absence of horizontal ties

θ = angle of strut inclination to the horizontal axis

σ_d = average normal stress in d-direction (negative for compression)

ζ = softening coefficient

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Table 2-1 Values of γ for beam-column joints with continuous column per ACI 352R-02

Classification	Connection type	
	1	2
Joints effectively confined on all four vertical faces	24	20
Joints effectively confined on three vertical faces or on two opposite vertical faces	20	15
Other cases	15	12

Table 4-1 — Specimen parameters for eccentric beam-column joints

Specimens		f'_c $[MPa]$	$\frac{N}{A_g f'_c}$	column (b × h) [mm]	Beam (b × h) [mm]	e, [mm]	$\frac{A_{sh\_provided}}{A_{sh\_req.}}$
Joh et al. (1991)	JX0-B5	23.0	0.13	300×300	150×350	75	0.32
Raffaelle and Wight (1995)	S1	28.6	0.02	350x350	254×381	50.8	1.37
	S2	26.8	0.03	350x350	178×381	88.9	1.47
	S3	37.7	0.02	350x350	190.5×381	82.5	1.04
	S4	19.3	0.04	350x350	190.5×600	82.5	2.03
Teng and Zhou (2003)	S2	34.0	0.11	400×300	200×400	50	0.91
	S3	35.0	0.10	400×300	200×400	100	0.89
	S5	39.0	0.12	400×200	200×400	50	0.84
	S6	38.0	0.12	400×200	200×400	100	0.86
Shin and LaFave (2004)	S1*	29.9	0.00	457×330	279×406	89	1.03
	S2*	36.2	0.00	457×330	279×406	140	0.85
Goto and Joh (2004)	UM-60	24.6	0.17	450×300	200×350	60	0.39
	UM-125	25.2	0.17	450×300	200×350	125	0.38
	UU-125	25.4	0.17	450×300	200×350	125	0.75
Kusuhara et al. (2004)	JE-55	27.0	0.00	320×280	180×300	55	0.19
	JE-55S	27.0	0.00	320×280	180×300	55	0.88
Lee and Ko (2007)	W75**	30.4	0.10	600×400	300×450	75	1.40
	W150**	29.1	0.10	600×400	300×450	150	1.40

* Specimens with slabs ** Specimens in T-shape form (exterior joint)

Table 4-2 — Three tiers of SST analysis for eccentric beam-column joints

Specimens		θ [deg.]	A_{th} [mm^2]	A_{tv} [mm^2]	f_{yh} [MPa]	f_{yv} [MPa]	SST Analysis 1			SST Analysis 2			SST Analysis 3		
							b_{j_1} [mm]	a_{s_1} [mm]	V_{SST_1} [kN]	b_{j_2} [mm]	a_{s_2} [mm]	V_{SST_2} [kN]	b_{j_3} [mm]	a_{s_3} [mm]	V_{SST_3} [kN]
Joh et al. (1991)	JX0-B5	50.42	57	133	307	370	222	113	206	242	147	287	242	147	295.48
Raffaelle and Wight (1995)	S1	47.31	314	286	476	441	318	105	403	320	117	449	320	117	437.42
	S2	47.31	314	286	476	441	242	106	290	257	122	356	257	122	359.41
	S3	47.31	314	286	476	441	254	94	381	262	111	456	262	111	442.41
	S4	59.07	314	286	476	441	257	120	214	270	127	232	270	127	249.62
Teng and Zhou (2003)	S2	60.28	236	314	440	530	318	121	378	327	149	470	327	149	502.92
	S3	60.28	236	314	440	530	268	120	330	277	149	415	277	149	445.47
	S5	60.28	236	314	440	530	293	76	265	309	112	390	309	112	418.32
	S6	60.28	236	314	440	530	247	77	226	248	97	277	248	97	300.18
Shin and LaFave (2004)	S1*	52.05	314	286	448	539	334	86	329	326	134	479	326	134	478.37
	S2*	52.06	314	286	448	539	334	94	301	229	149	456	229	149	457.28
Goto and Joh (2004)	UM-60	50.41	85	201	355	384	343	236	684	357	190	579	357	190	584.63
	UM-125	50.41	85	201	355	384	278	232	564	292	190	489	292	190	493.33
	UU-125	50.41	85	201	355	384	278	231	566	292	190	493	292	190	497.05
Kusuhara et al. (2004)	JE-55	47.58	57	402	247	345	242	101	252	249	126	324	249	126	352.65
	JE-55S	47.58	214	402	247	345	242	101	263	249	126	335	249	126	363.99
Lee and Ko (2007)	W75**	51.56	707	380	471	455	464	173	923	481	184	1,005	481	184	970.29
	W150**	51.56	471	380	471	455	389	174	737	407	184	805	407	184	782.08

Table 4-3 — Statistical value of shear strength ratios between experimental and predicted values for eccentric joints using SST analysis

Specimens		V_{test}, [kN]	SST Analysis		
			$\frac{V_{test}}{V_{SST\_1}}$	$\frac{V_{test}}{V_{SST\_2}}$	$\frac{V_{test}}{V_{SST\_3}}$
Joh et al. (1991)	JX0-B5	294	1.42	1.02	0.99
Raffaelle and Wight (1995)	S1	605	1.50	1.35	1.38
	S2	421	1.45	1.18	1.17
	S3	472	1.24	1.03	1.07
	S4	412	1.92	1.78	1.65
Teng and Zhou (2003)	S2	758	2.01	1.61	1.51
	S3	743	2.25	1.79	1.67
	S5	434	1.64	1.11	1.04
	S6	437	1.94	1.58	1.46
Shin and LaFave (2004)	S1*	645	1.96	1.35	1.35
	S2*	649	2.15	1.42	1.42
Goto and Joh (2004)	UM-60	779	1.14	1.35	1.33
	UM-125	666	1.18	1.36	1.35
	UU-125	632	1.12	1.28	1.27
Kusuhara et al. (2004)	JE-55	519	2.05	1.60	1.47
	JE-55S	516	1.96	1.54	1.47
Lee and Ko (2007)	W75**	781	0.85	0.78	0.80
	W150**	739	1.00	0.92	0.94
		Mean	**1.60**	**1.34**	**1.29**
		COV	**0.28**	**0.22**	**0.19**

* Specimens with slabs

** Specimens in T-shape form (exterior joint)

Table 5-1 — Specimen parameters for concentric exterior joints (1/3)

Specimens		f'_c, $[MPa]$	γ	column(b×h), [mm]	Beam(b×h), [mm]	$\frac{A_{sh\_provided}}{A_{sh\_req.}}$	$\frac{N}{A_g f'_c}$[%]
Hanson (1971)	S4	37.09	12	381×381	305×508	1.26	50.43
	S5	36.13	12	381×381	305×508	1.29	28.97
Yamaguchi et al. (1980)	N22	25.68	12	500×500	350×550	0.40	0.00
	N25	21.95	12	500×500	350×550	0.47	0.00
	N29	22.15	12	500×500	350×550	0.46	0.00
	N35	23.03	12	500×500	350×550	0.44	0.00
	L25	23.13	12	500×500	350×550	0.44	0.00
	2P13	22.93	12	270×270	190×300	0.15	0.00
	2P16	21.85	12	270×270	190×300	0.16	0.00
	4P16	23.42	12	270×270	190×300	0.15	0.00
	2P19	21.95	12	270×270	190×300	0.16	0.00
	S16	22.54	12	270×270	190×300	0.15	0.00
Paulay and Scarpas (1981)	Unit 1	22.60	12	457×457	356×610	1.53	5.30
	Unit 2	22.50	12	457×457	356×610	1.04	15.00
	Unit 3	26.90	12	457×457	356×610	0.87	5.30
Kanada et al. (1984)	U41L	26.66	12	300×300	260×385	0.57	0.00
	U42L	30.09	12	300×300	260×385	1.01	0.00
	U40L	24.30	12	300×300	260×383	0.00	0.00

Table 5-1 —Specimen parameters for concentric exterior joints (2/3)

Specimens		f_c', [MPa]	γ	column(b×h), [mm]	Beam(b×h), [mm]	$\frac{A_{sh\_provided}}{A_{sh\_req.}}$	$\frac{N}{A_g f_c'}$[%]
Ehsani and Wight (1985)	Spec 1B	33.60	12	300×300	260×480	0.87	5.89
	Spec 3B	40.90	12	300×300	260×480	1.30	6.04
	Spec 4B	44.60	12	300×300	260×440	1.48	5.53
	Spec 5B	24.30	12	340×340	300×480	0.78	12.63
	Spec 6B	39.80	12	340×340	300×480	0.74	6.59
Ehsani et al. (1987)	Spec 1	64.67	12	340×340	300×480	0.91	2.14
	Spec 2	67.30	12	340×340	300×480	0.88	4.34
	Spec 3	64.70	12	300×300	260×440	0.90	6.58
	Spec 4	67.30	12	300×300	260×440	0.93	5.37
Alameddine (1991)	LL8	56.50	12	356×356	318×508	0.91	4.11
	LH8	56.50	12	356×356	318×508	0.91	4.11
	HH8	56.50	12	356×356	318×508	0.91	7.09
	HL8	56.50	12	356×356	318×508	0.91	7.09
	LL11	74.50	12	356×356	318×508	0.69	6.66
	LH11	74.50	12	356×356	318×508	0.69	6.66
	HH11	74.50	12	356×356	318×508	0.69	6.66
	HL11	74.50	12	356×356	318×508	0.69	6.66
	LL14	92.40	12	356×356	318×508	0.53	5.14
	LH14	92.40	12	356×356	318×508	0.53	5.14
	HH14	92.40	12	356×356	318×508	0.53	5.14

Table 5-1 —Specimen parameters for concentric exterior joints (3/3)

Specimens		f_c', $[MPa]$	γ	column(b× h), [mm]	Beam(b× h), [mm]	$\frac{A_{sh\_provided}}{A_{sh\_req.}}$	$\frac{N}{A_g f_c'}$ [%]
Fujii and Morita (1991)	B1	30.00	12	220×220	160×250	0.32	6.89
	B2	30.00	12	220×220	160×250	0.38	6.89
	B3	30.00	12	220×220	160×250	0.38	24.11
	B4	30.00	12	220×220	160×250	1.02	24.11
Castro and Imai (2004)	A-No.1	50.00	12	400×400	350×450	0.65	10.00
	A-No.2	70.00	12	400×400	350×450	0.46	10.00
	A-No.5	21.00	12	400×400	350×450	1.55	10.00
	A-No.7	50.00	12	400×400	350×450	0.65	10.00
	A-No.10	50.00	12	400×400	350×450	0.65	10.00
Hwang et al. (2005)	3T4	75.20	12	450×450	320×450	0.95	1.29
	2T5	76.60	12	450×450	320×450	0.28	1.26
	1T55	69.70	12	450×450	320×450	0.23	1.39
	3T44	76.80	12	420×420	320×450	0.22	1.45
	3T3	69.00	12	420×420	320×450	0.43	1.61
	2T4	71.00	12	420×420	320×450	0.31	1.56
	1T44	72.80	12	420×420	320×450	0.34	1.53
Lee and Ko (2007)	S0	28.50	12	400×600	300×450	1.54	10.00
	W0	29.50	12	600×400	300×450	1.26	10.00

Table 5-2 —Statistical value of shear strength ratios between experimental and predicted values for concentric exterior joints (1/2)

Specimens		$V_{test}[kN]$	Failure Mode	$\frac{V_{test}}{V_{ACI318-08}}$	$\frac{V_{test}}{V_{ACI352-02}}$	$\frac{V_{test}}{V_{proposed}}$
Hanson (1971)	S4	814.29	J	0.92	1.02	0.92
	S5	884.75	J	1.01	1.13	1.01
Yamaguchi et al. (1980)	N22	668.87	BF	0.53	0.62	0.53
	N25	904.94	BF	0.77	0.91	0.77
	N29	802.10	BF	0.68	0.80	0.68
	N35	598.97	BF	0.50	0.59	0.50
	L25	649.29	BF	0.54	0.64	0.54
	2P13	314.64	BF	0.90	1.06	0.90
	2P16	278.90	BF	0.82	0.96	0.82
	4P16	276.78	BF	0.78	0.92	0.78
	2P19	261.51	BF	0.77	0.90	0.77
	S16	280.23	BF	0.81	0.95	0.81
Paulay and Scarpas (1981)	Unit 1	750.89	BJ	0.76	0.85	0.76
	Unit 2	988.29	BJ	1.00	1.12	1.00
	Unit 3	754.46	BJ	0.70	0.78	0.70
Kanada et al. (1984)	U41L	364.00	BJ	0.78	0.84	0.78
	U42L	361.50	BJ	0.73	0.78	0.73
	U40L	275.00	J	0.62	0.66	0.62
Ehsani and Wight (1985)	Spec 1B	555.45	J	1.07	1.14	1.07
	Spec 3B	589.68	BJ	1.03	1.10	1.03
	Spec 4B	636.80	BJ	1.06	1.14	1.06
	Spec 5B	568.26	J	1.00	1.06	1.00
	Spec 6B	452.32	BJ	0.62	0.66	0.62
Ehsani et al. (1987)	Spec 1	644.50	BF	0.69	0.74	0.69
	Spec 2	789.10	BJ	0.83	0.88	0.83
	Spec 3	671.10	BJ	0.93	1.00	0.93
	Spec 4	726.70	BJ	0.99	1.06	0.99

Table 5-2 —Statistical value of shear strength ratios between experimental and predicted values for concentric exterior joints (2/2)

Specimens		$V_{test}[kN]$	Failure Mode	$\frac{V_{test}}{V_{ACI318-08}}$	$\frac{V_{test}}{V_{ACI352-02}}$	$\frac{V_{test}}{V_{proposed}}$
Alameddine (1991)	LL8	860.66	BJ	0.91	0.96	0.91
	LH8	838.49	BJ	0.88	0.93	0.88
	HH8	985.67	BJ	1.04	1.10	1.04
	HL8	986.78	J	1.04	1.10	1.04
	LL11	769.14	BJ	0.70	0.74	0.70
	LH11	934.28	BJ	0.86	0.90	0.86
	HH11	1021.01	BJ	0.94	0.99	0.94
	HL11	967.81	J	0.89	0.94	0.89
	LL14	878.01	BJ	0.72	0.76	0.72
	LH14	890.63	BJ	0.73	0.77	0.73
	HH14	1032.75	BJ	0.85	0.90	0.85
Fujii and Morita (1991)	B1	255.00	J	0.96	1.11	0.96
	B2	214.00	BJ	0.81	0.93	0.81
	B3	273.00	J	1.03	1.19	1.03
	B4	287.00	J	1.08	1.25	1.08
Castro and Imai (2004)	A-No.1	1064.30	BJ	0.94	1.00	0.94
	A-No.2	1131.90	BF	0.85	0.90	0.85
	A-No.5	930.00	J	1.27	1.35	1.27
	A-No.7	1109.00	BJ	0.98	1.05	0.98
	A-No.10	1070.00	J	0.95	1.01	0.95
Hwang et al. (2005)	3T4	1110.00	BF	0.63	0.74	0.63
	2T5	1162.00	BF	0.66	0.77	0.66
	1T55	1126.00	BF	0.67	0.78	0.67
	3T44	1065.00	BF	0.69	0.78	0.69
	3T3	1132.00	BJ	0.77	0.88	0.77
	2T4	1080.00	BJ	0.73	0.82	0.73
	1T44	1039.00	BJ	0.69	0.78	0.69
Lee and Ko (2007)	S0	699.00	BF	0.55	0.62	0.55
	W0	778.00	BJ	0.60	0.80	0.72

Table 5-3 —Specimen parameters for concentric interior joints (1/3)

Specimens		f_c' [MPa]	γ	column(b×h), [mm]	Beam(b×h), [mm]	$\frac{A_{sh\_provided}}{A_{sh\_req.}}$	$\frac{N}{A_g f_c'}$[%]
Hanson (1971)	S1	37.92	15	381×381	305×508	1.23	50.43
	S2	20.20	20	381×381	305×508	2.32	57.94
Meinheit and Jirsa (1977)	SI	26.20	15	330×457	280×457	0.53	39.47
	SII	41.78	15	330×457	280×457	0.38	24.75
	SIII	26.61	15	330×457	280×457	0.63	38.86
	SIV	36.06	15	457×330	406×457	0.50	28.68
	SV	35.85	15	330×457	280×457	0.47	3.86
	SVI	36.75	15	330×457	280×457	0.46	46.90
	SVII	37.23	15	457×330	406×457	0.27	46.30
	SVIII	33.10	20	330×457	280×457	0.51	31.25
	SIX	31.03	15	330×457	280×457	0.54	33.33
	SX	29.58	15	330×457	280×457	0.57	34.96
	SXI	25.65	15	457×330	406×457	0.39	40.32
	SXII	35.16	15	330×457	280×457	2.56	29.41
	SXIII	41.30	15	330×457	280×457	1.22	25.04
	SXIV	33.16	15	457×330	406×457	0.91	31.18
Fenwick and Irvine (1977)	Unit 1	32.50	15	250×300	200×300	2.54	0.00
	Unit 3	33.50	15	250×300	200×300	2.88	0.00
Birss (1978)	B1	27.90	15	457×457	356×610	1.71	0.00
	B2	31.50	15	457×457	356×610	0.36	0.00

Table 5-3 —Specimen parameters for concentric interior joints (2/3)

Specimens		f'_c $[MPa]$	γ	column(b× h), [mm]	Beam(b× h), [mm]	$\frac{A_{sh\_provided}}{A_{sh\_req.}}$	$\frac{N}{A_g f'_c}$[%]
Viwathanatepa et al. (1979)	BC3	31.10	12	432×432	229×406	0.59	36.04
	BC4	31.51	12	432×432	229×406	0.58	34.92
Beckingsale (1980)	B11	34.70	15	457×457	356×610	3.10	5.00
	B12	34.20	15	457×457	356×610	3.15	5.00
	B13	28.90	15	457×457	356×610	3.09	5.00
Park et al. (1981)	Unit 1	34.00	15	305×406	230×457	0.90	23.66
Park and Milburn (1983)	Unit 1	41.30	15	305×406	230×457	2.21	10.00
	Unit 2	46.90	15	305×406	230×457	1.12	10.00
Rabbat et al. (1982)	NC1	36.82	15	381×381	305×660	0.64	22.50
	NC2	35.58	15	381×381	305×660	0.67	21.16
	NC3	32.47	15	381×381	305×660	0.77	25.50
Durrani and Wight (1985)	X1	34.34	15	362×362	280×420	0.88	6.38
	X2	33.65	15	362×362	280×420	1.35	6.05
	X3	31.03	15	362×362	280×420	0.91	4.96
Abrams (1987)	LIJ3	31.10	15	343×457	343×343	0.90	0.00

Table 5-3 —Specimen parameters for concentric interior joints (3/3)

Specimens		f_c' $[MPa]$	γ	column(b×h), [mm]	Beam(b×h), [mm]	$\frac{A_{sh\_provided}}{A_{sh\_req.}}$	$\frac{N}{A_g f_c'}$[%]
Durrani and Wight (1987)	S1	41.58	20	362×362	280×420	0.75	7.98
	S2	30.75	20	362×362	280×420	1.53	8.41
	S3	28.27	20	362×362	280×420	1.03	6.49
Goto et al. (1988)	HH	25.87	12	300×300	200×350	1.57	16.67
	HL	27.44	12	300×300	200×350	1.48	16.67
	MH	28.13	12	300×300	200×350	0.70	16.67
	LH	26.85	12	300×300	200×350	0.38	16.67
Leon (1990)	BCJ2	27.40	15	254×254	203×305	0.91	0.00
	BCJ3	27.20	15	254×254	203×305	0.92	0.00
Fujii and Morita (1991)	A1	40.18	12	220×220	160×250	0.29	7.71
	A2	40.18	12	220×220	160×250	0.29	7.71
	A3	40.18	12	220×220	160×250	0.29	23.14
	A4	40.18	12	220×220	160×250	0.77	23.14
Au et al. (2003)	E-0.0	43.10	15	300×300	250×300	0.00	0.00
	E-0.3	46.10	15	300×300	250×300	0.00	30.00
	H-0.0	50.60	15	300×300	250×300	1.68	0.00
	H-0.3	45.10	15	300×300	200×350	1.65	30.00

Table 5-4 —Statistical value of shear strength ratios between experimental and predicted values for concentric interior joints (1/2)

Specimens		$V_{test}[kN]$	Failure Mode	$\frac{V_{test}}{V_{ACI318-08}}$	$\frac{V_{test}}{V_{ACI352-02}}$	$\frac{V_{test}}{V_{proposed}}$
Hanson (1971)	S1	1166.14	BF	1.04	1.16	1.04
	S2	1163.921	BF	1.07	1.19	1.07
Meinheit and Jirsa (1977)	SI	1089.81	J	1.13	1.22	1.13
	SII	1596.90	J	1.31	1.42	1.31
	SIII	1227.70	J	1.26	1.37	1.26
	SIV	1454.56	J	1.28	1.36	1.28
	SV	1530.18	J	1.35	1.47	1.35
	SVI	1645.83	BJ	1.44	1.56	1.44
	SVII	1467.91	J	1.27	1.35	1.27
	SVIII	1721.46	BJ	1.19	1.29	1.19
	SIX	1596.91	J	1.52	1.65	1.52
	SX	1476.81	J	1.44	1.56	1.44
	SXI	1285.54	J	1.35	1.42	1.35
	SXII	1948.31	BJ	1.74	1.89	1.74
	SXIII	1556.87	J	1.28	1.39	1.28
	SXIV	1539.08	J	1.42	1.50	1.42
Fenwick and Irvine (1977)	Unit 1	524.94	BJ	0.98	1.09	0.98
	Unit 3	590.67	BJ	1.09	1.21	1.09
Birss (1978)	B1	1214.40	BJ	0.88	0.99	0.88
	B2	1208.30	BJ	0.82	0.93	0.82
Viwathanatepa et al. (1979)	BC3	792.70	BF	0.76	1.00	0.76
	BC4	873.90	BF	0.83	1.09	0.83
Beckingsale (1980)	B11	844.80	BF	0.55	0.62	0.55
	B12	844.70	BF	0.55	0.62	0.55
	B13	844.70	BF	0.60	0.68	0.60
Park et al. (1981)	Unit 1	958.74	BJ	1.06	1.21	1.06
Park and Milburn(1983)	Unit 1	1001.00	BJ	1.01	1.15	1.01
	Unit 2	994.00	BJ	0.94	1.07	0.94
Rabbat et al. (1982)	NC1	978.60	J	0.89	0.99	0.89
	NC2	871.85	J	0.81	0.90	0.81
	NC3	871.85	J	0.84	0.94	0.84

Table 5-4 —Statistical value of shear strength ratios between experimental and predicted values for concentric interior joints (2/2)

Specimens		$V_{test}[kN]$	Failure Mode	$\frac{V_{test}}{V_{ACI318-08}}$	$\frac{V_{test}}{V_{ACI352-02}}$	$\frac{V_{test}}{V_{proposed}}$
Durrani and Wight (1985)	X1	839.82	BJ	0.88	0.99	0.88
	X2	853.16	BJ	0.90	1.01	0.90
	X3	627.64	BJ	0.69	0.78	0.69
Abrams (1987)	LIJ3	724.00	BJ	0.66	0.66	0.66
Durrani and Wight (1987)	S1	923.90	BF	0.66	0.74	0.66
	S2	924.78	BF	0.77	0.87	0.77
	S3	720.61	BF	0.62	0.70	0.62
Goto et al. (1988)	HH	353.91	BF	0.77	0.93	0.77
	HL	322.34	BF	0.68	0.82	0.68
	MH	322.84	BF	0.68	0.81	0.68
	LH	347.21	BF	0.74	0.89	0.74
Leon (1990)	BCJ2	358.00	BJ	0.85	0.94	0.85
	BCJ3	394.00	BJ	0.94	1.04	0.94
Fujii and Morita (1991)	A1	412.00	J	1.34	1.55	1.34
	A2	380.00	J	1.24	1.43	1.24
	A3	412.00	J	1.34	1.55	1.34
	A4	421.00	J	1.37	1.59	1.37
Au et al. (2003)	E-0.0	750.40	J	1.02	1.11	1.02
	E-0.3	813.90	J	1.07	1.16	1.07
	H-0.0	869.30	J	1.09	1.19	1.09
	H-0.3	743.90	J	0.98	1.07	0.98

Table 5-5 —Statistical value of shear strength ratios between experimental and predicted values for eccentric joints

Specimens		V_{test}, [kN]	Failure Mode	$\frac{V_{test}}{V_{ACI318-08}}$	$\frac{V_{test}}{V_{ACI352-02}}$	$\frac{V_{test}}{V_{LaFave}}$	$\frac{V_{test}}{V_{proposed}}$
Joh et al. (1991)	JX0-B5	294	BJ	1.36	1.05	0.91	0.91
Raffaelle and Wight (1995)	S1	605	BJ	1.25	1.04	1.04	0.93
	S2	421	BJ	1.29	0.99	0.86	0.86
	S3	472	BJ	1.13	0.89	0.79	0.77
	S4	412	BJ	1.39	1.08	0.97	0.94
Teng and Zhou (2003)	S2	758	BJ	1.45	1.45	1.45	1.33
	S3	743	BJ	2.09	1.71	1.40	1.52
	S5	434	BJ	1.16	1.16	1.16	1.16
	S6	437	BJ	1.77	1.54	1.18	1.42
Shin and LaFave (2004)	S1*	645	BJ	1.28	1.09	0.97	0.99
	S2*	649	BJ	1.84	1.44	1.03	1.26
Goto and Joh (2004)	UM-60	779	J	1.59	1.81	1.61	1.54
	UM-125	666	J	2.21	1.80	1.36	1.61
	UU-125	632	J	2.09	1.71	1.29	1.52
Kusuhara et al. (2004)	JE-55	519	BJ	1.70	1.50	1.43	1.35
	JE-55S	516	BJ	1.69	1.50	1.42	1.34
Lee and Ko (2007)	W75**	781	BJ	0.79	0.79	0.79	0.75
	W150**	739	BJ	1.14	0.95	0.76	0.86
Mean				**1.51**	**1.30**	**1.13**	**1.17**
COV				**0.26**	**0.26**	**0.24**	**0.25**

* Specimens with slabs

** Specimens in T-shape form (exterior joint)

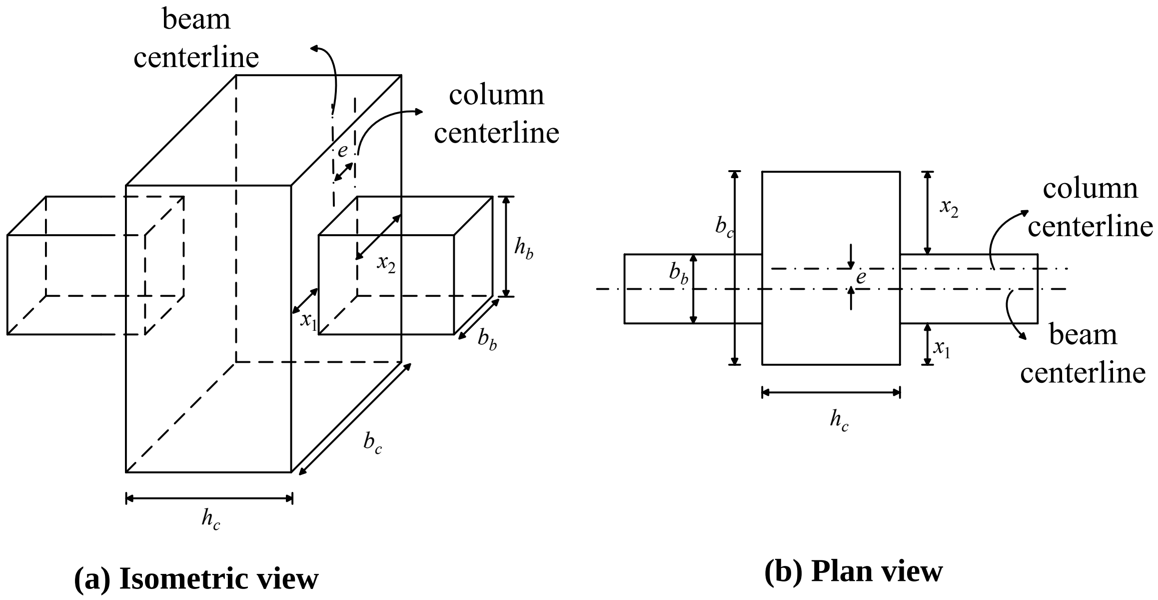


Figure 1-1 — Typical eccentric RC beam-column Joint

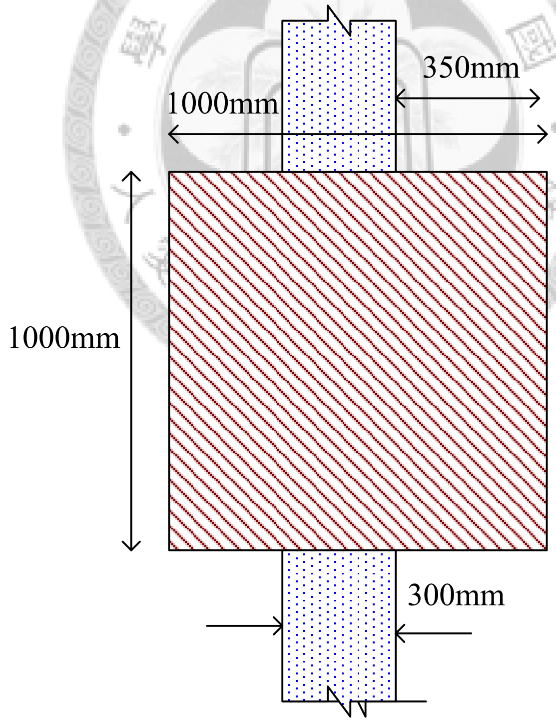
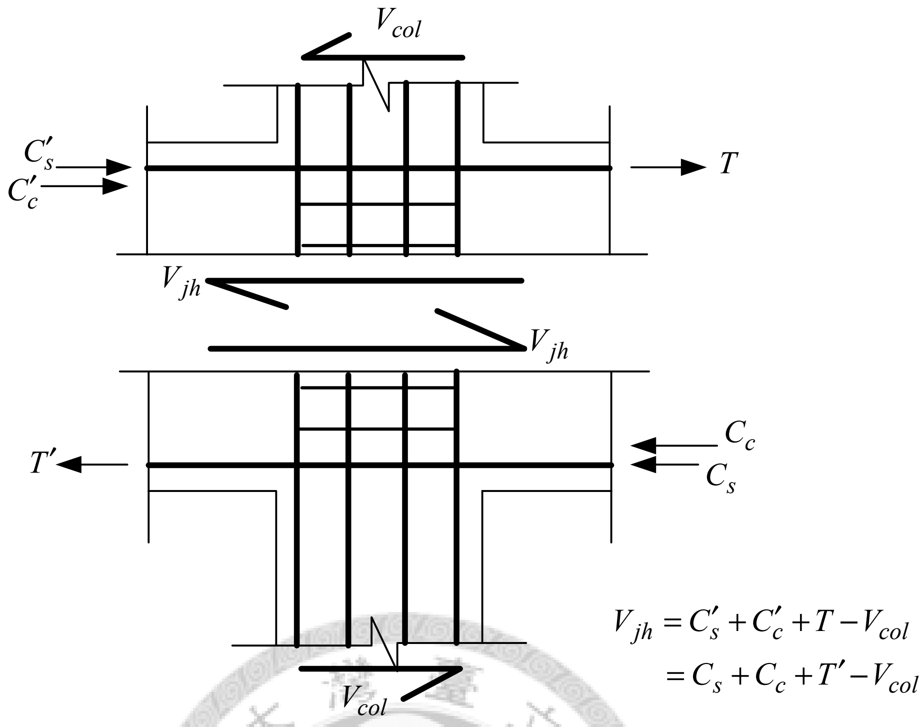
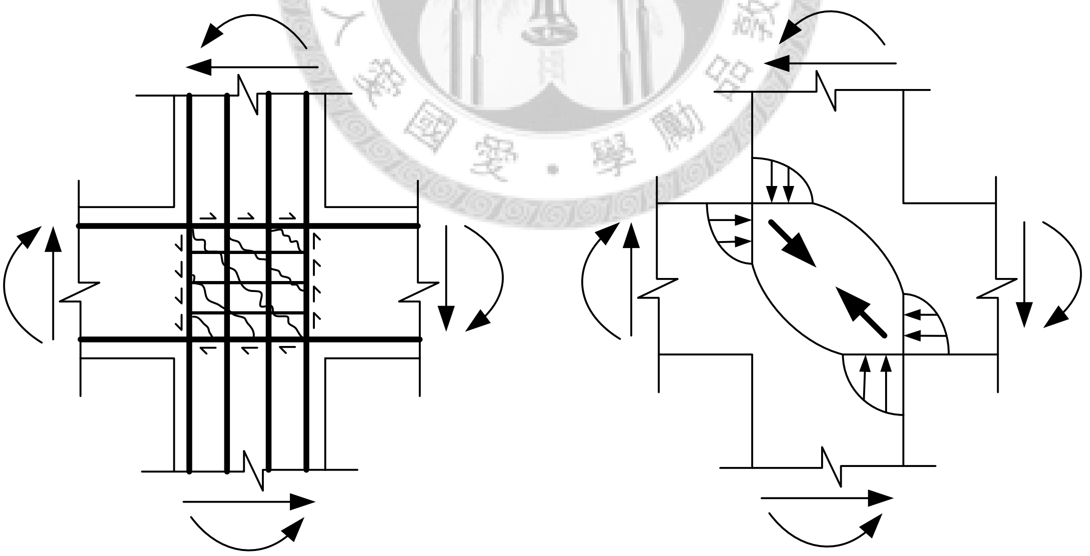


Figure 1-2 — Illustration on wide column – narrow beam connection



$$V_{jh} = C_s' + C_c' + T - V_{col}$$
$$= C_s + C_c + T' - V_{col}$$

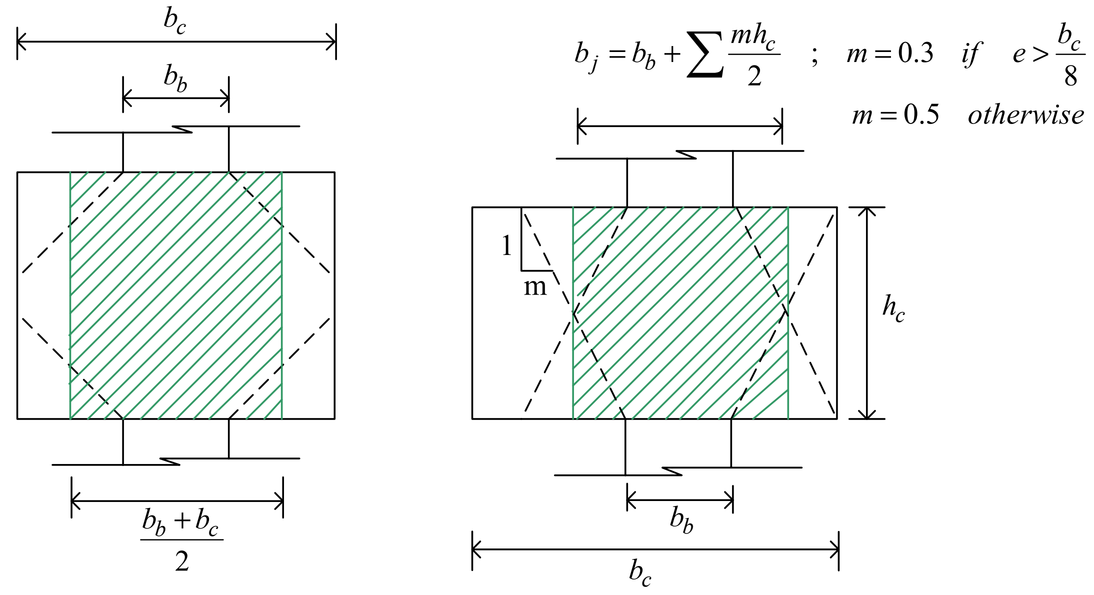
Figure 2-1 — Horizontal acting shear forces
(vertical forces not shown)



(a) Truss Mechanisms

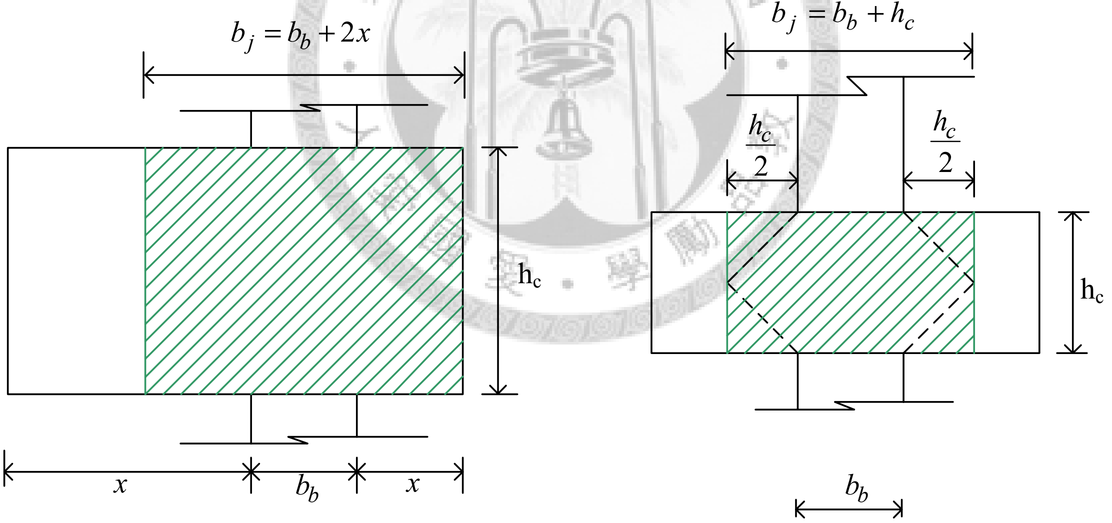
(b) Diagonal Strut Mechanisms

Figure 2-2 — Shear resisting mechanisms



(a) Illustration of Equation 2-2(a) **(b) Illustration of Equation 2-2(b)**

Figure 2-3 — Illustrative determination of b_j per ACI 352R-02



(a) Illustration of Equation 2-3(a) **(b) Illustration of Equation 2-3(b)**

Figure 2-4 — Illustrative determination of b_j per ACI 318-08

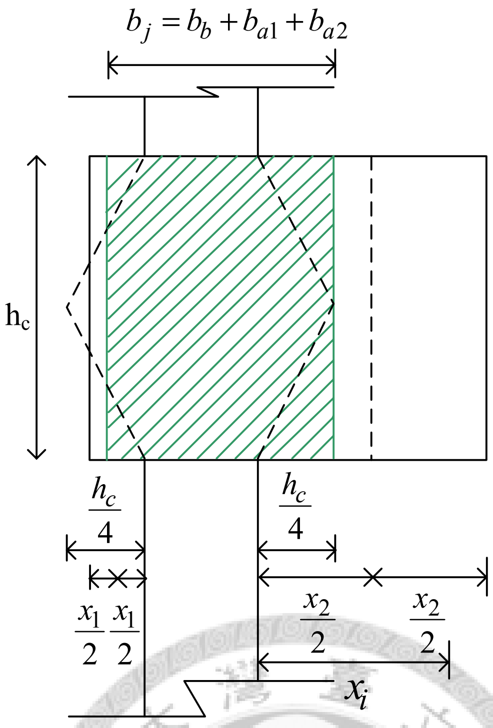


Figure 2-5 — Illustrative determination of b_j per AIJ Guideline 1999

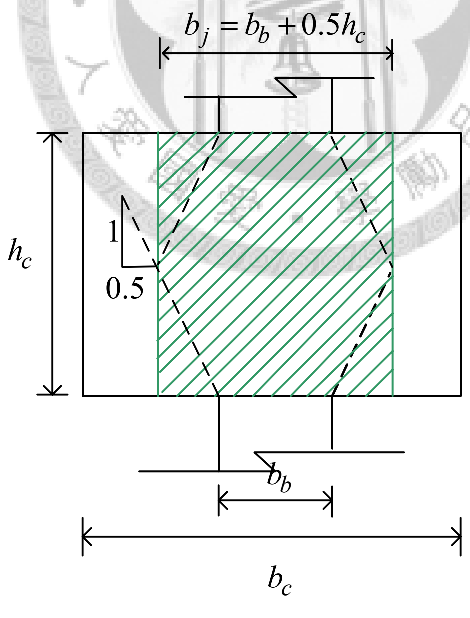
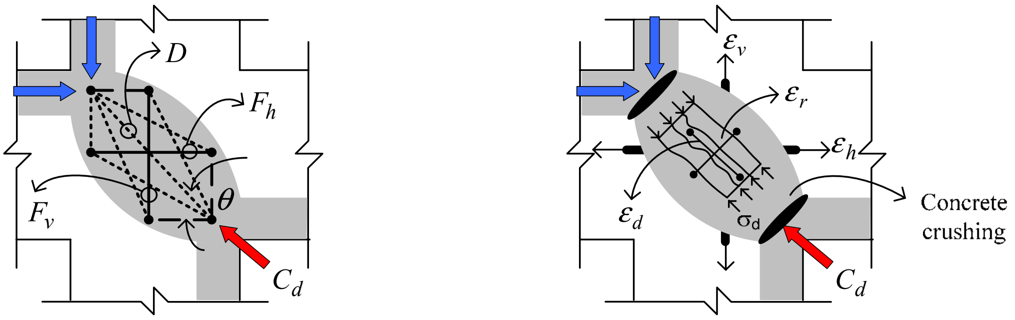
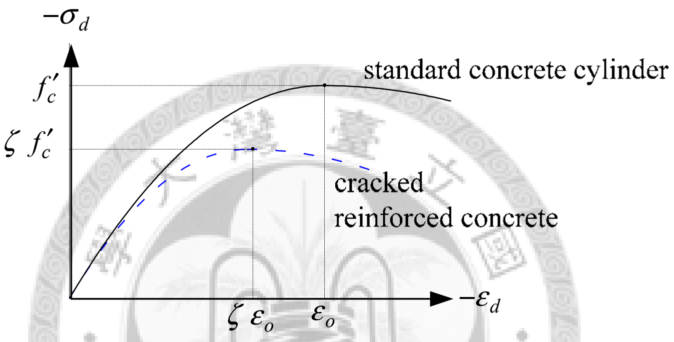


Figure 2-6 — Illustrative determination of b_j per NZS 3101



(a) Equilibrium checked by strut-and-tie model **(b) Mohr's compatibility criteria**



(c) Constitutive law for softened reinforced concrete

Figure 2-7 — Softened strut-and-tie model

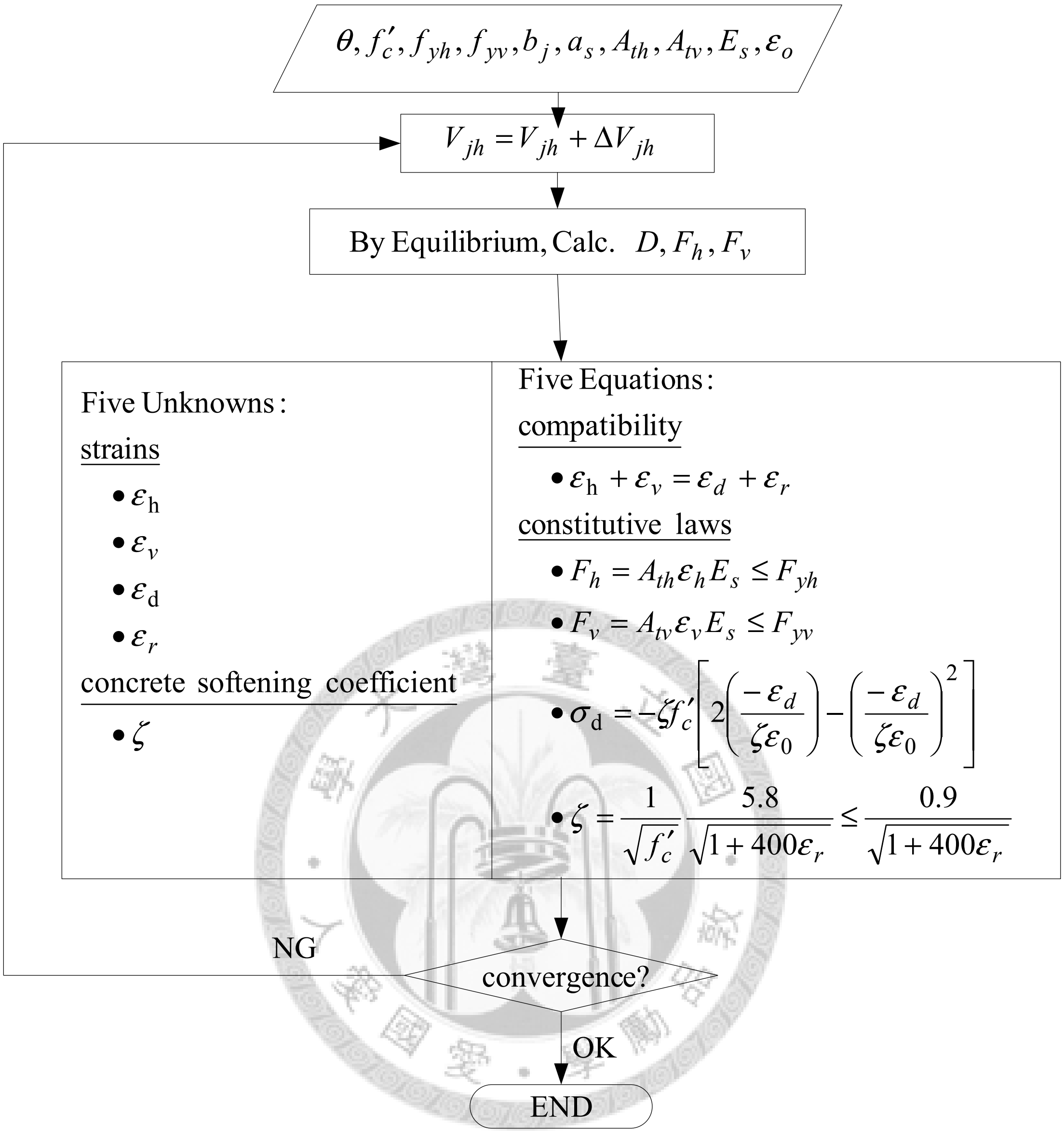


Figure 2-8 — Solution algorithm for general SST approach

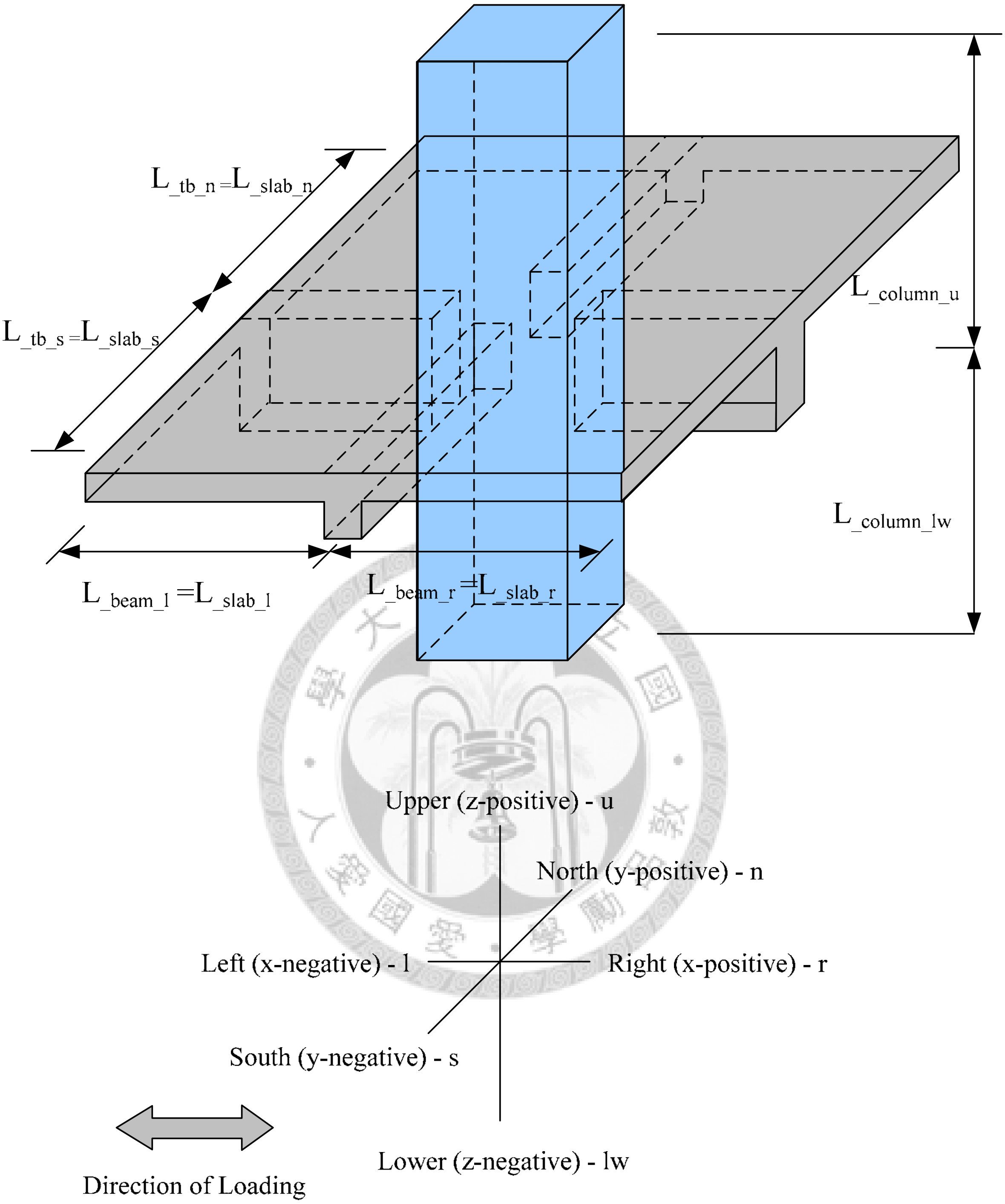


Figure 3-1 — General joint geometry and coordinate convention

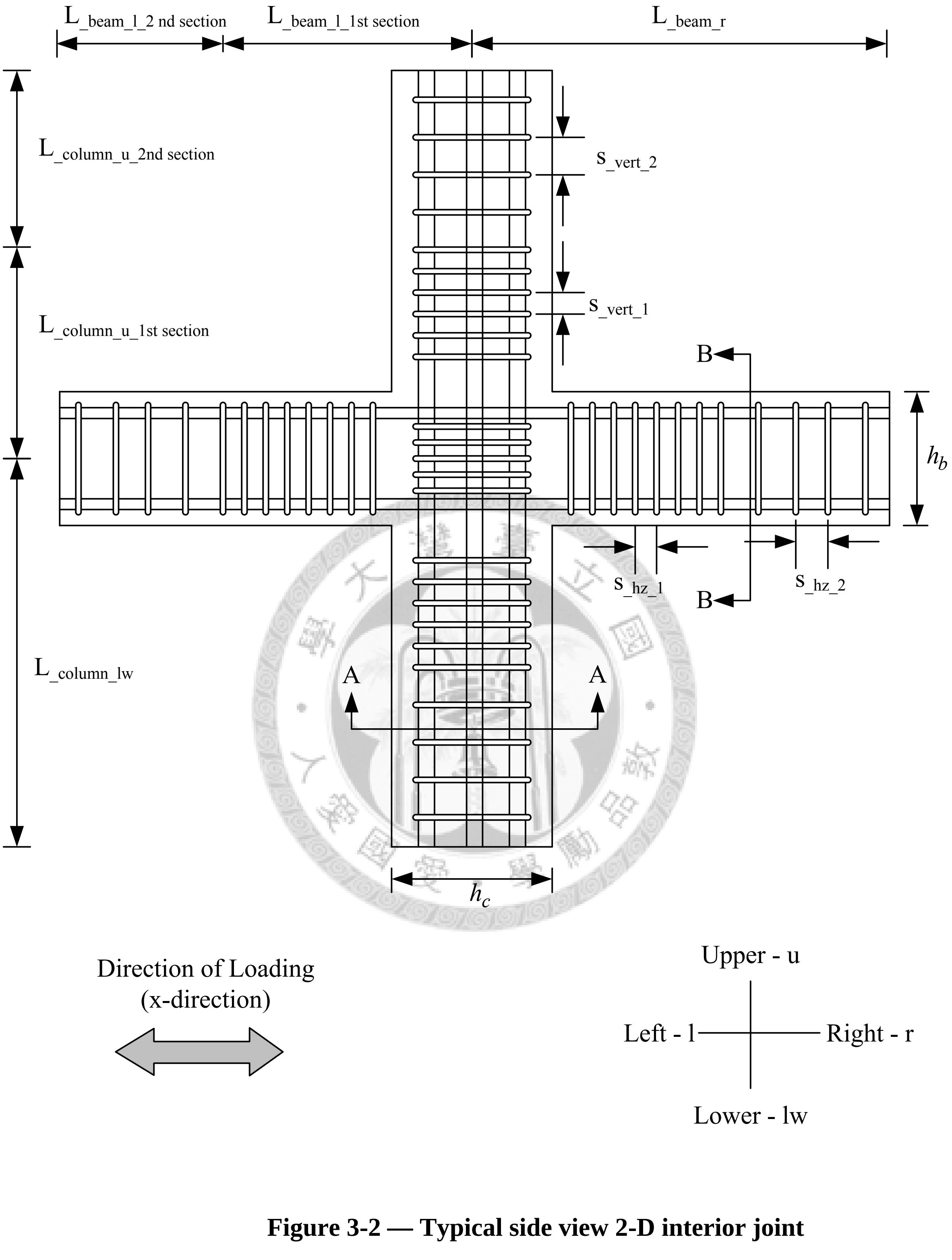
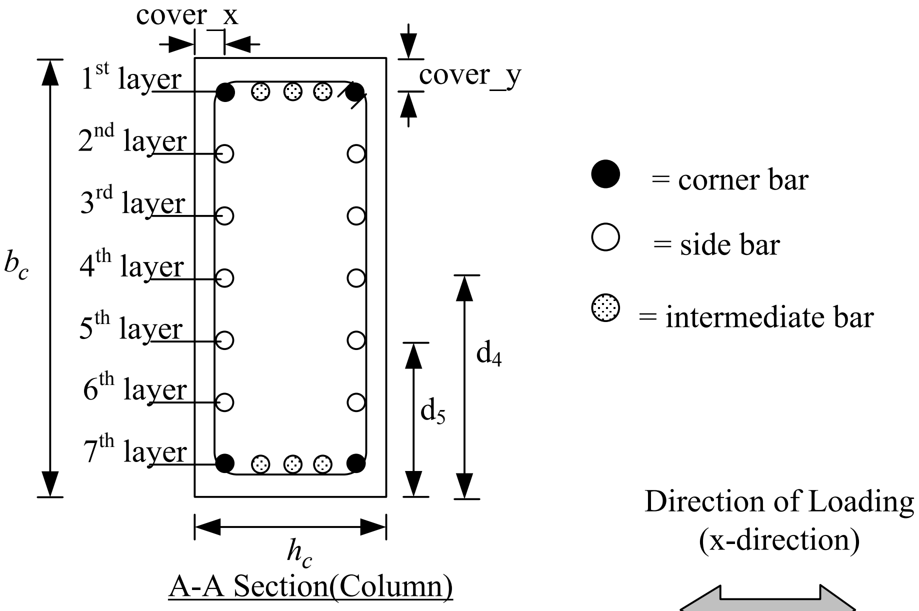
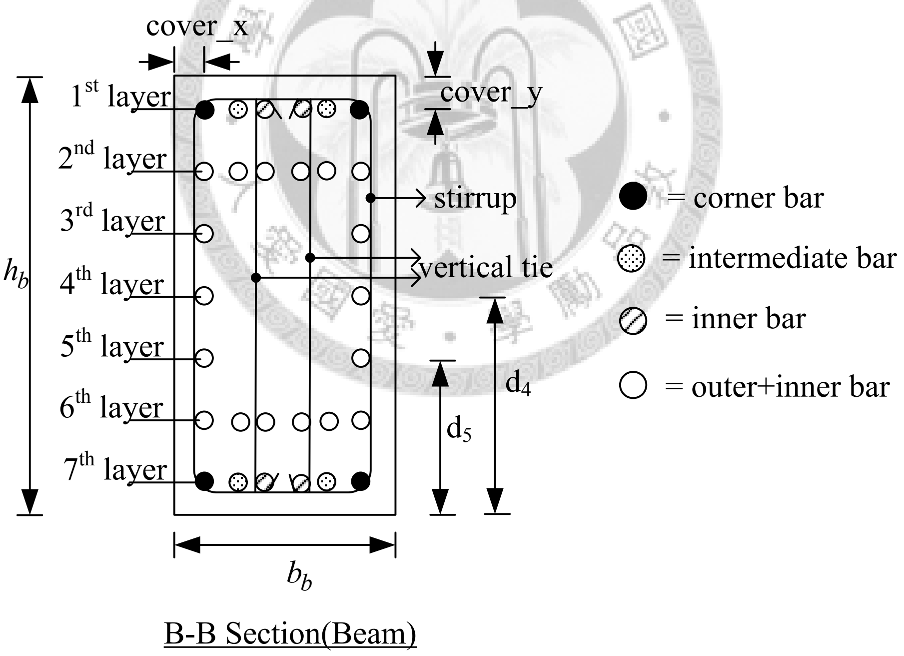


Figure 3-2 — Typical side view 2-D interior joint

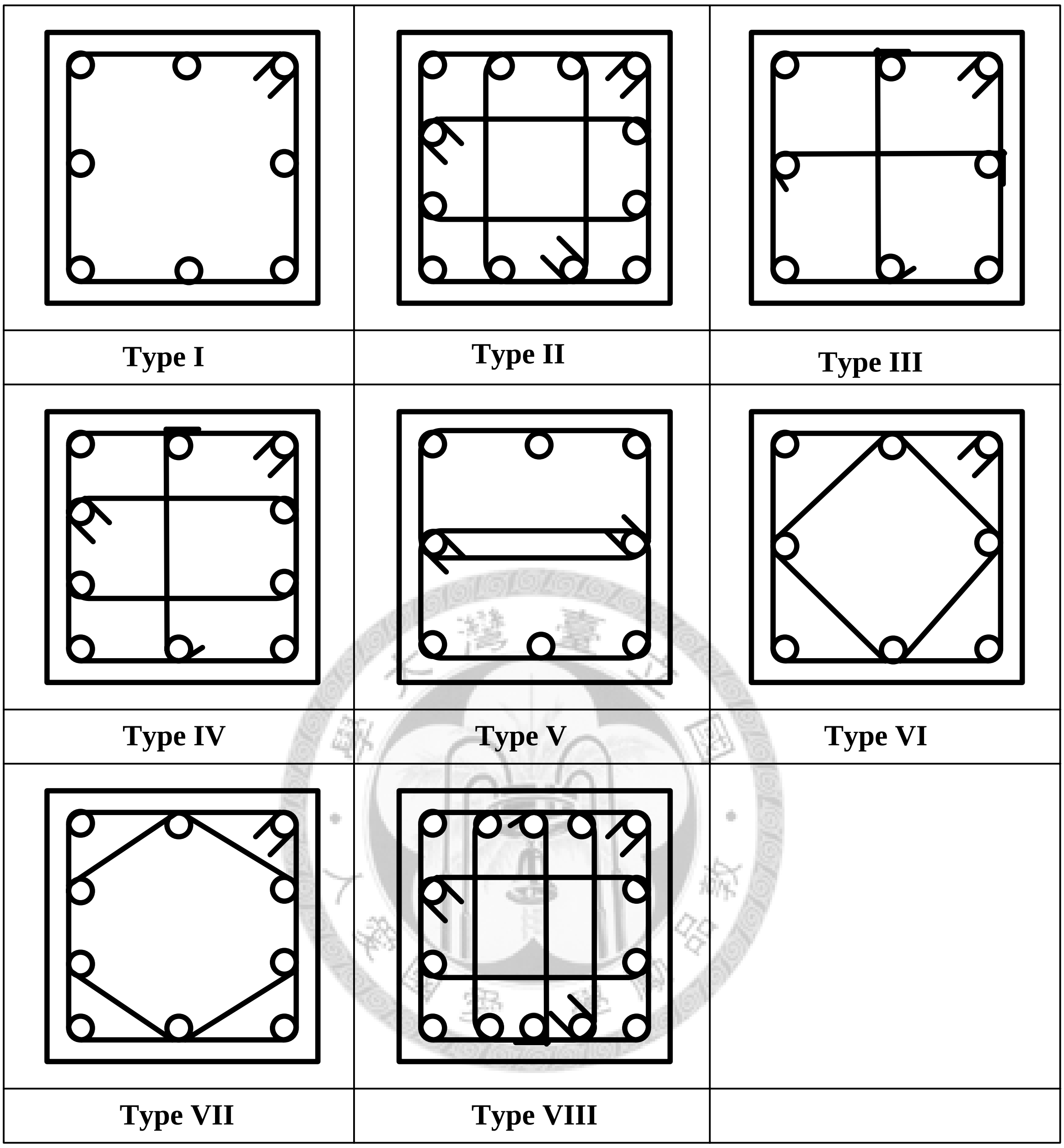


(a) column cross section



(b) beam cross section

Figure 3-3 — Cross section of column and beam



Type I

Type II

Type III

Type IV

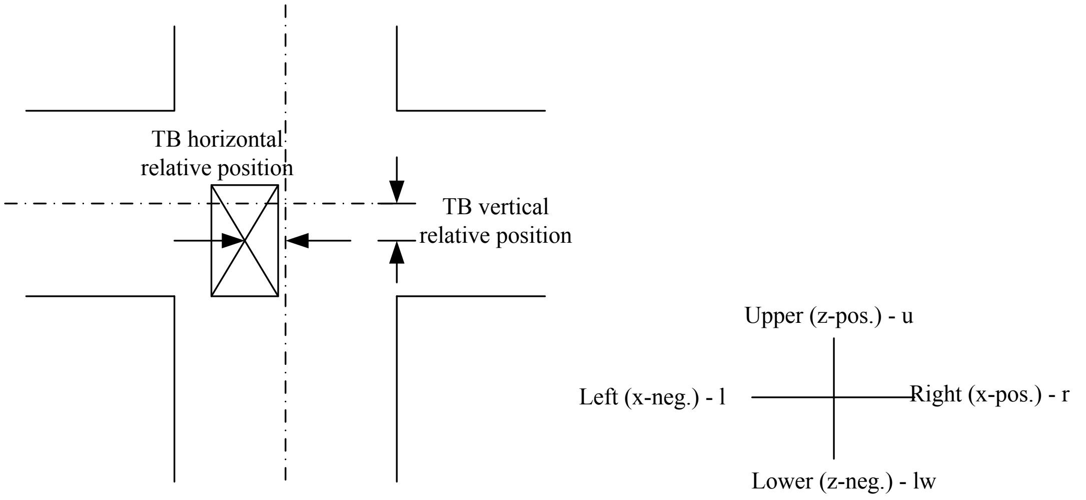
Type V

Type VI

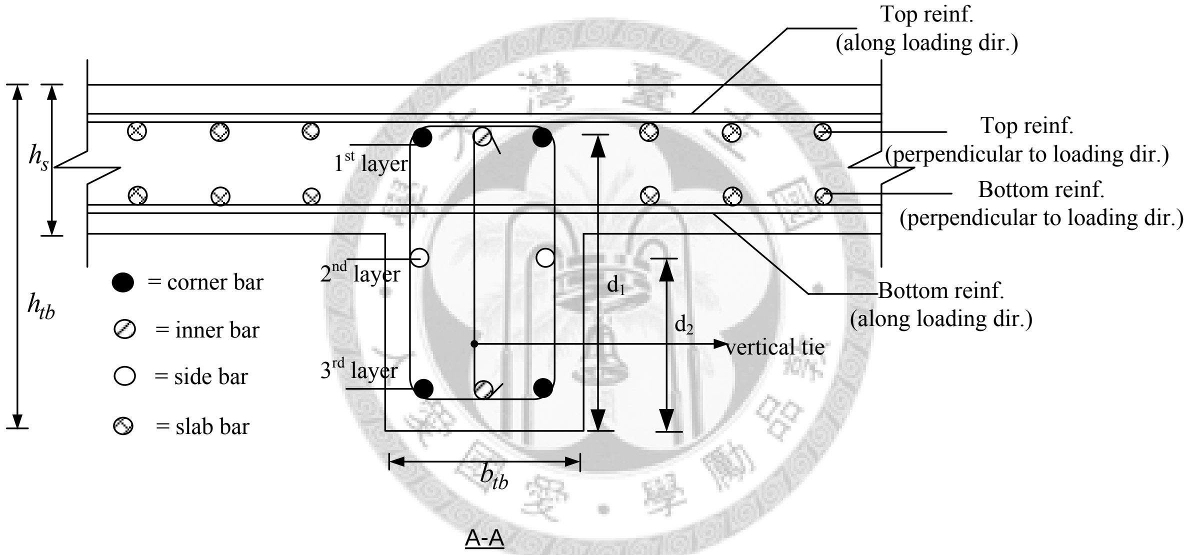
Type VII

Type VIII

Figure 3-4 — Types of transverse reinforcement

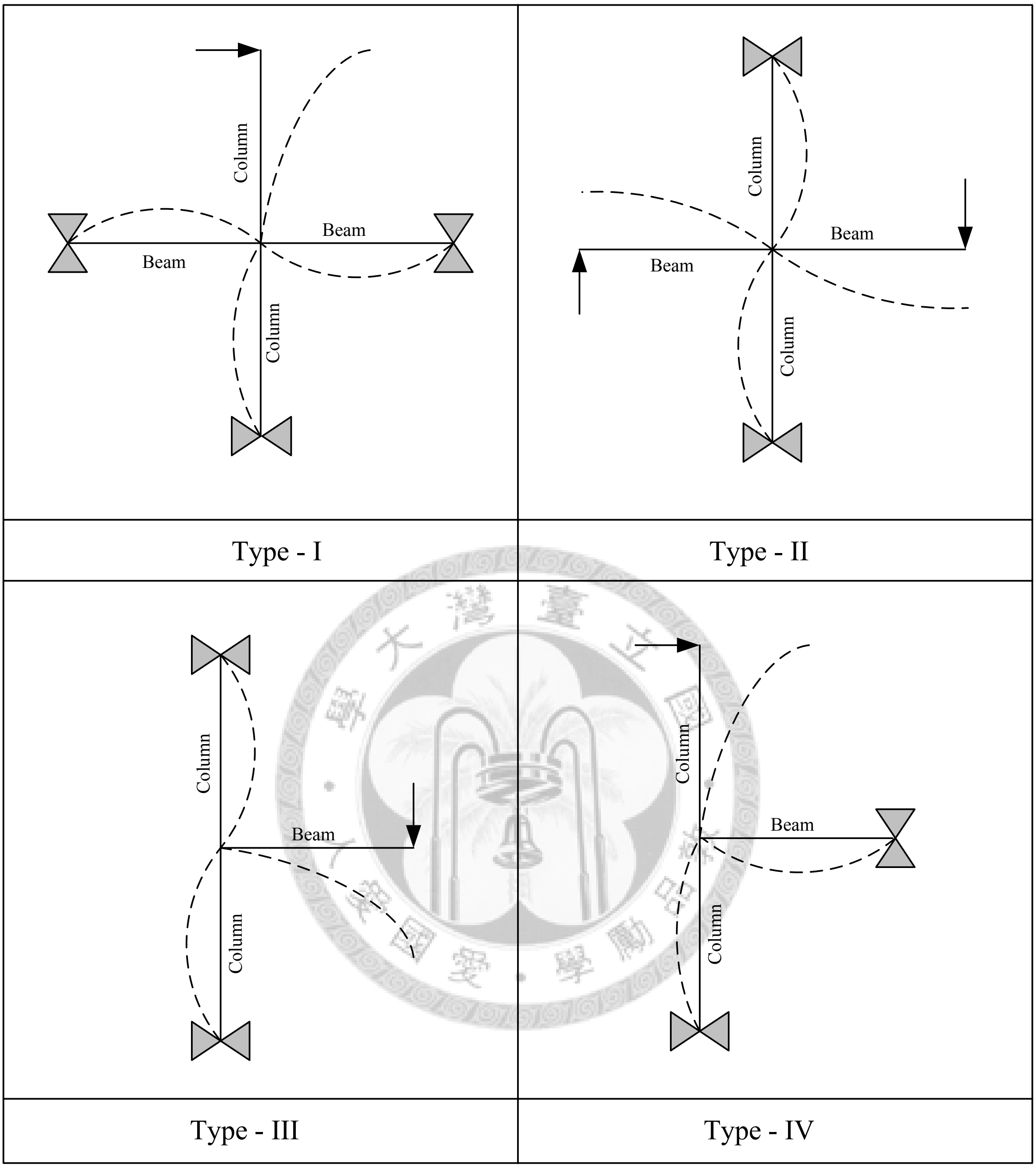


(a) Relative position of transverse beam



(b) Cross section of transverse beam and slab

Figure 3-5 — Transverse beam and slab



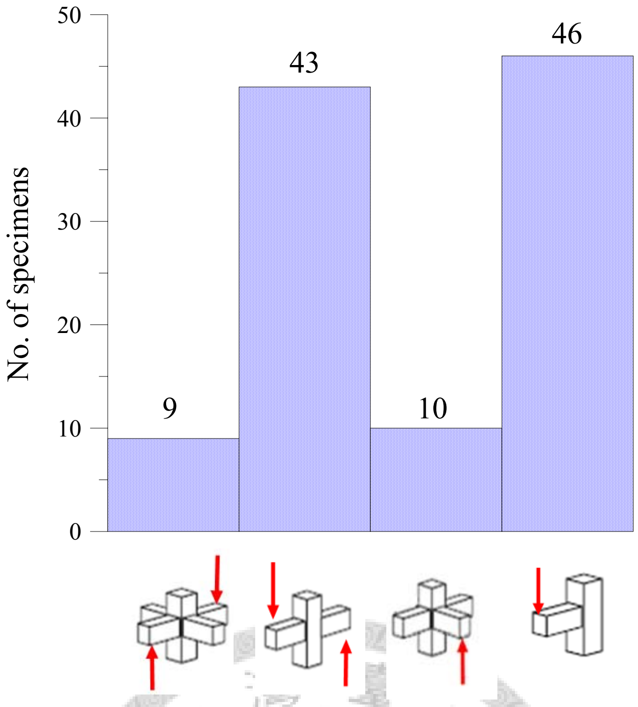
Type - I

Type - II

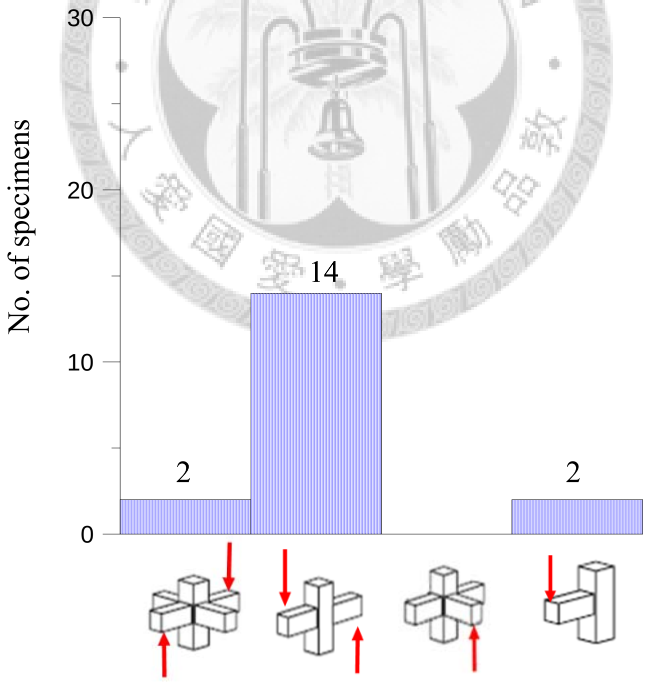
Type - III

Type - IV

Figure 3-6 — Type of loading input

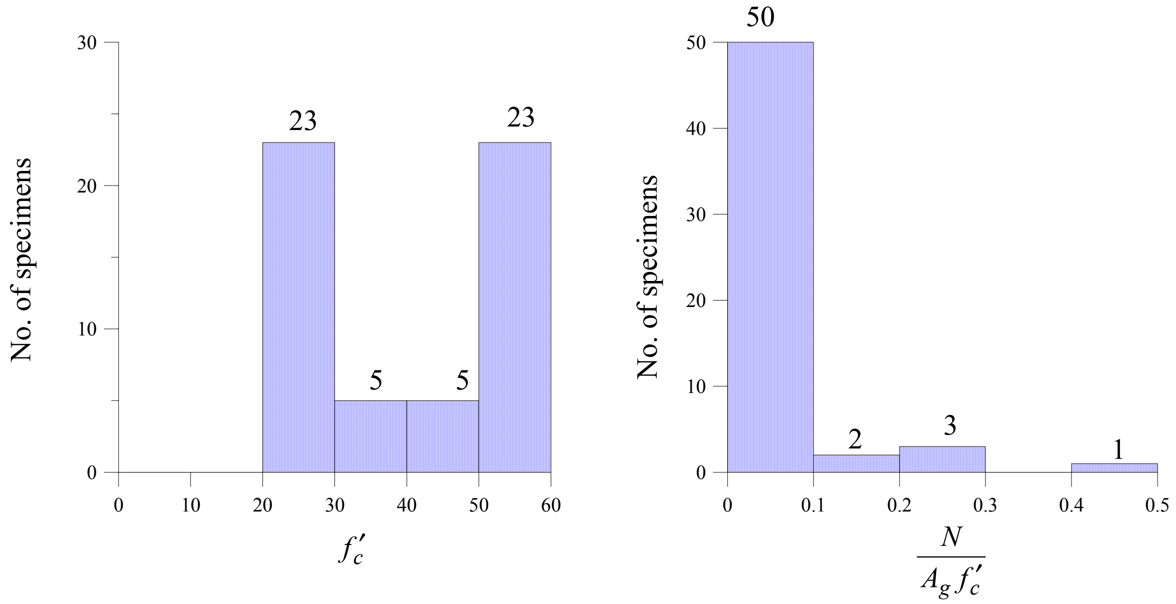


(a) — Concentric joints

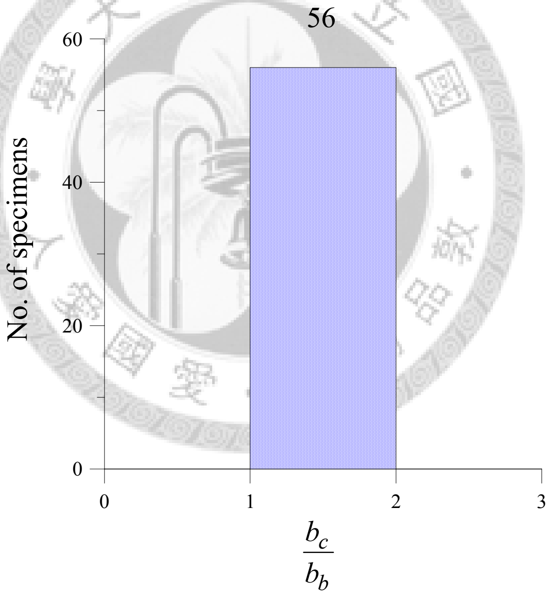


(b) — Eccentric joints

Figure 3-7 — Database characteristics for beam-column joints based on geometry

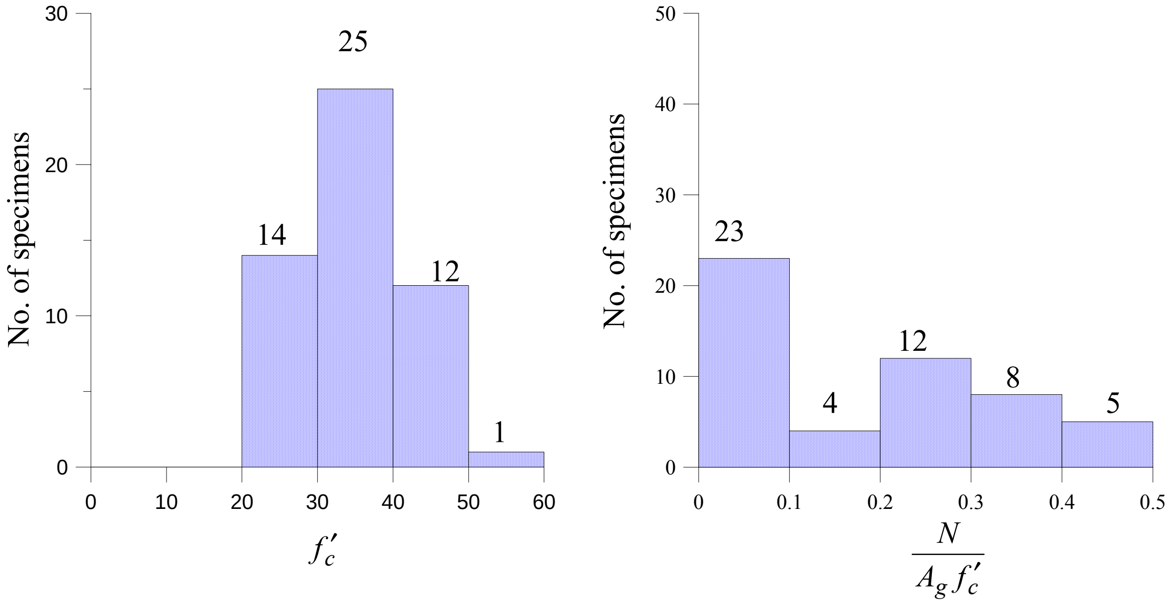


(a) – Based on concrete strength **(b) – Based on axial load ratio**



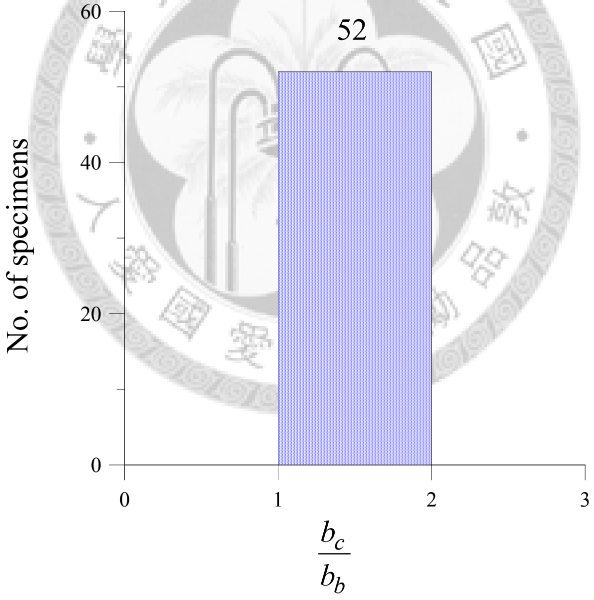
(c) – Based on ratio of $\frac{b_c}{b_b}$

Figure 3-8 — Database characteristics for concentric exterior beam-column Joints



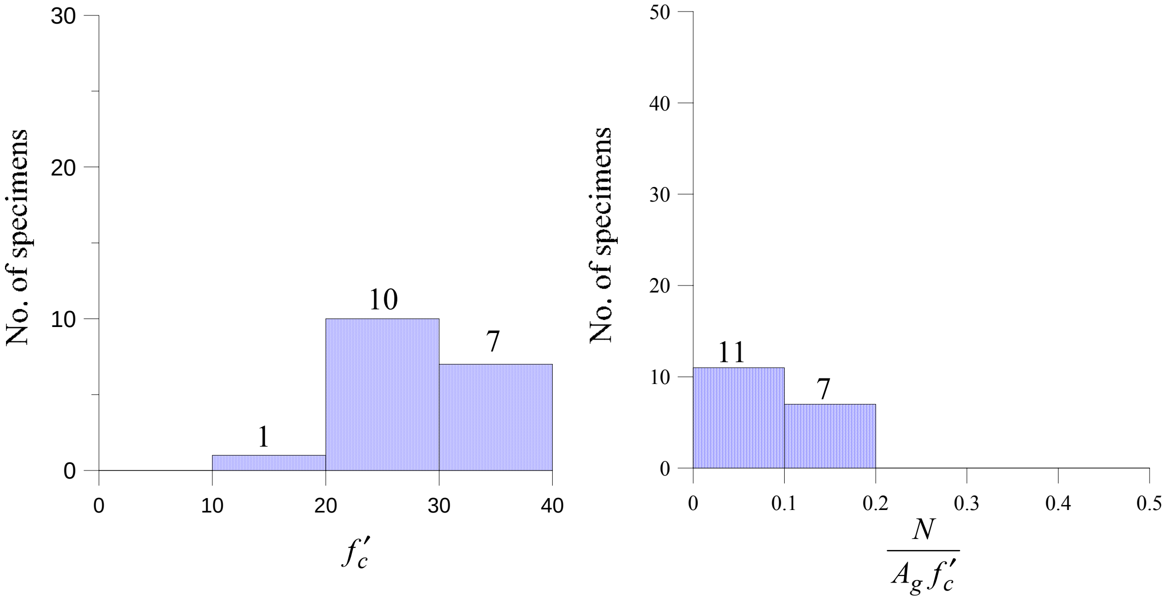
(a) – **Based on concrete strength**

(b) – **Based on axial load ratio**



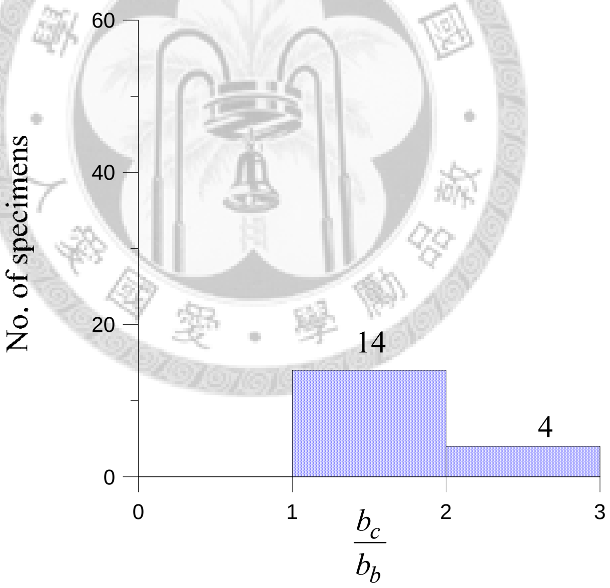
(c) – **Based on ratio of** $\frac{b_c}{b_b}$

Figure 3-9 — Database characteristics for concentric interior beam-column joints



(a) – **Based on concrete strength**

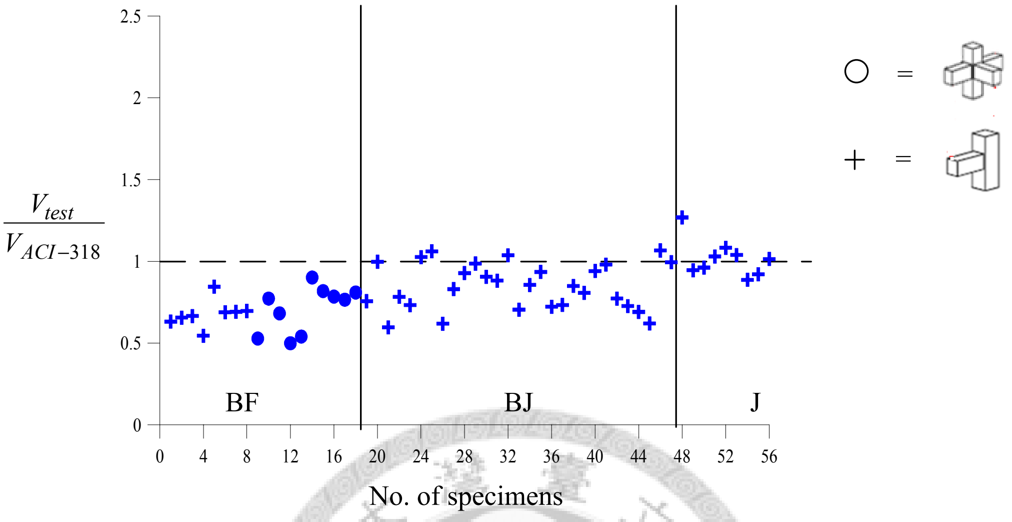
(b) – **Based on axial load ratio**



(c) – **Based on ratio of** $\frac{b_c}{b_b}$

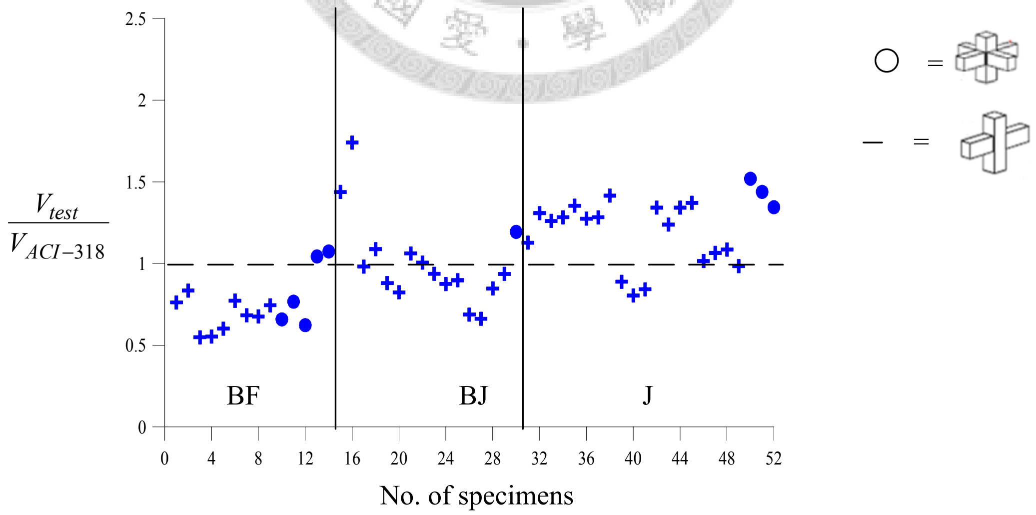
Figure 3-10 — Database characteristics for eccentric beam-column joints

	BF-type	BJ-type	J-type
$\frac{V_{test}}{V_{ACI-318}}$	Mean :0.70 COV : 0.17	Mean :0.84 COV : 0.16	Mean :0.99 COV : 0.15



(a) — ACI 318-08 strength ratio vs no. of specimens for concentric exterior joints

	BF-type	BJ-type	J-type
$\frac{V_{test}}{V_{ACI-318}}$	Mean :0.74 COV : 0.22	Mean :1.00 COV : 0.27	Mean :1.21 COV : 0.17



(b) — ACI 318-08 strength ratio vs no. of specimens for concentric interior joints

Figure 3-11 — Joint shear strength ratio vs no. of specimens for concentric exterior joints

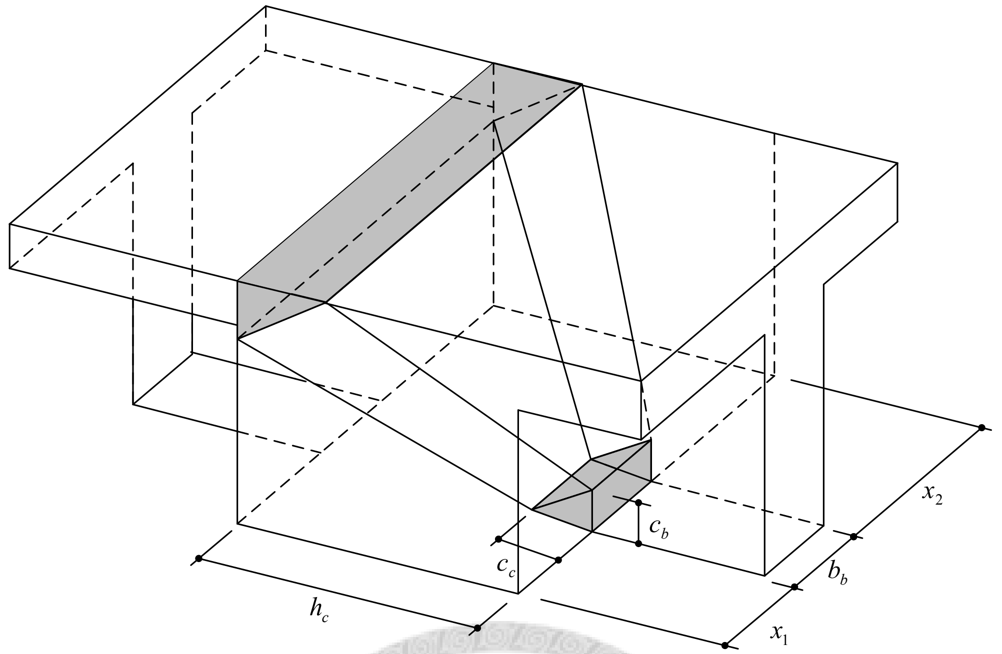
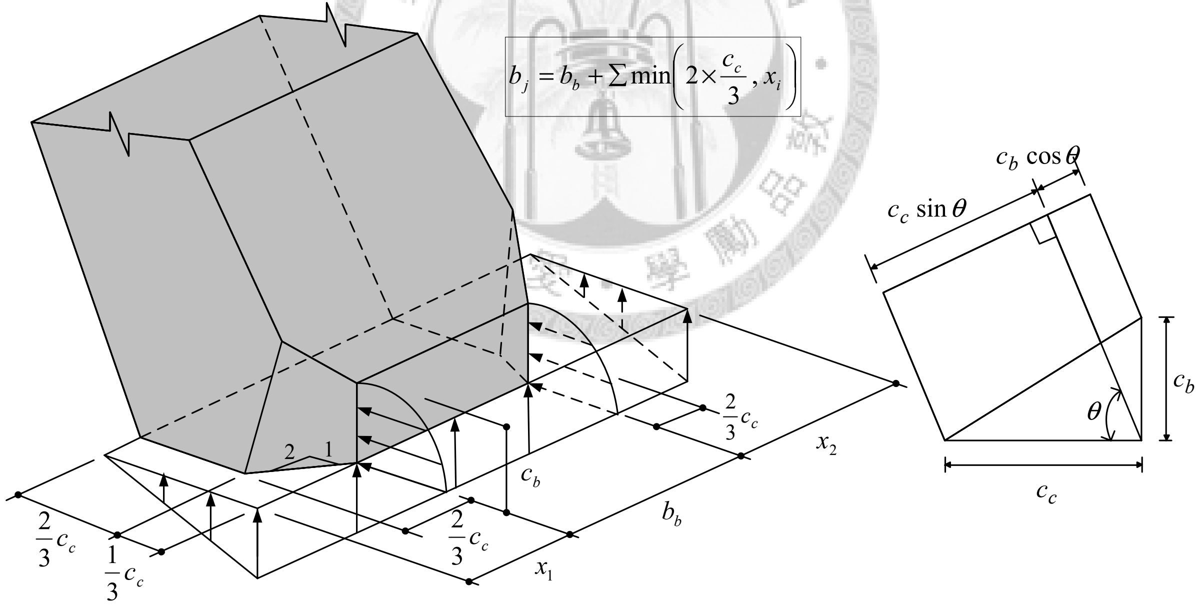


Figure 4-1 — Schematic view of diagonal compressive strut within joint



(a) Effective joint width

(b) Depth of strut

Figure 4-2 — Ilustration on determination of the strut area

	BF-type (Mean/COV)	BJ-type (Mean/COV)	J-type (Mean/COV)	BJ-type +J -type (Mean/COV)
$\frac{V_{test}}{V_{ACI-318}}$	(0.70/0.17)	(0.84/0.16)	(0.99/0.15)	(0.89/0.17)
$\frac{V_{test}}{V_{ACI-352}}$	(0.80/0.16)	(0.91/0.15)	(1.08/0.16)	(0.97/0.17)
$\frac{V_{test}}{V_{proposed}}$	(070/0.17)	(0.85/0.15)	(0.99/0.15)	(0.89/0.17)

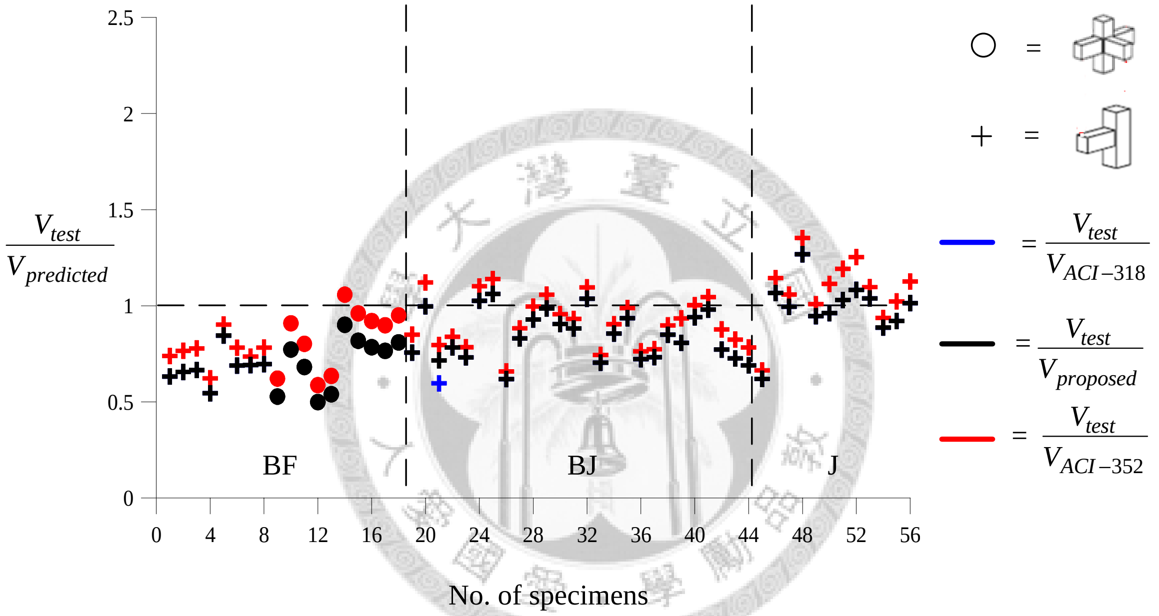


Figure 5-1 — Joint shear strength ratio vs no. of specimens for concentric exterior joints

	BF-type (Mean/COV)	BJ-type (Mean/COV)	J-type (Mean/COV)	BJ-type +J -type (Mean/COV)
$\frac{V_{test}}{V_{ACI-318}}$	(0.74/0.22)	(1.00/0.27)	(1.21/0.17)	(1.12/0.22)
$\frac{V_{test}}{V_{ACI-352}}$	(0.87/0.22)	(1.11/0.26)	(1.33/0.17)	(1.24/0.22)
$\frac{V_{test}}{V_{proposed}}$	(0.74/0.22)	(1.00/0.27)	(1.21/0.17)	(1.12/0.22)

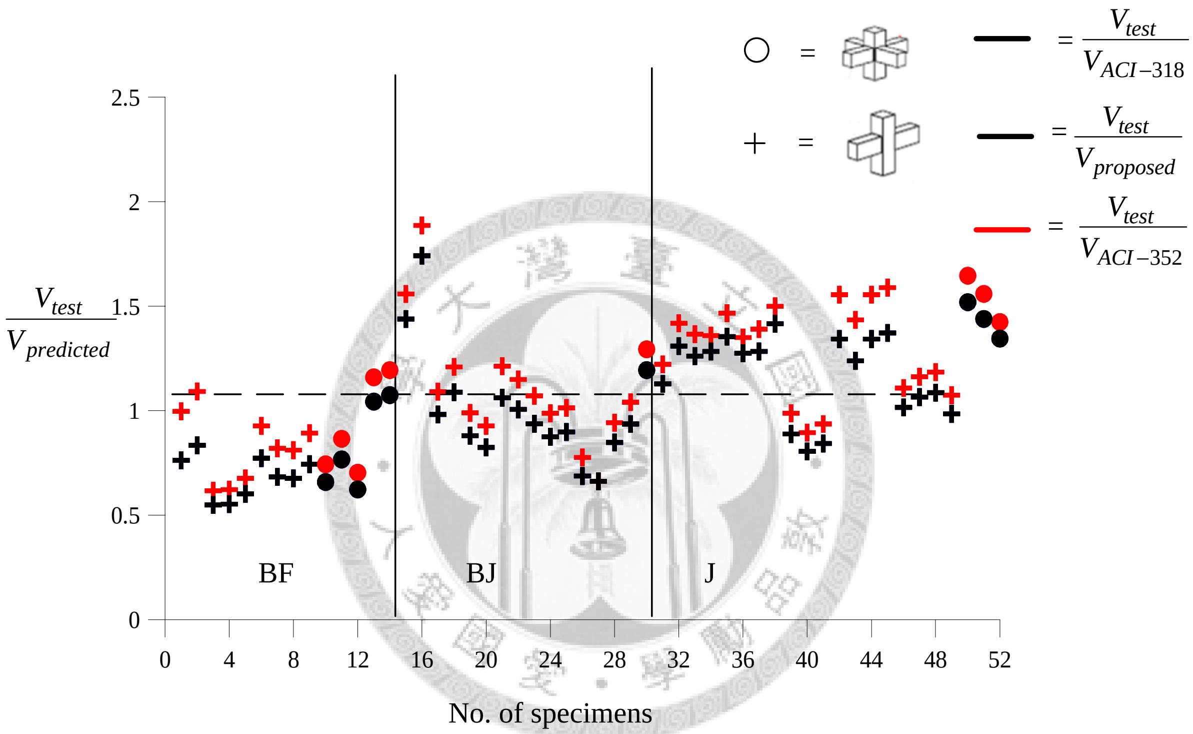


Figure 5-2 — Joint shear strength ratio vs no. of specimens for concentric interior joints

	BJ-type +J -type
$\frac{V_{test}}{V_{ACI-318}}$	Mean :1.51 COV : 0.26
$\frac{V_{test}}{V_{ACI-352}}$	Mean :1.30 COV : 0.26
$\frac{V_{test}}{V_{LaFave}}$	Mean :1.13 COV : 0.24
$\frac{V_{test}}{V_{proposed}}$	Mean :1.17 COV : 0.25

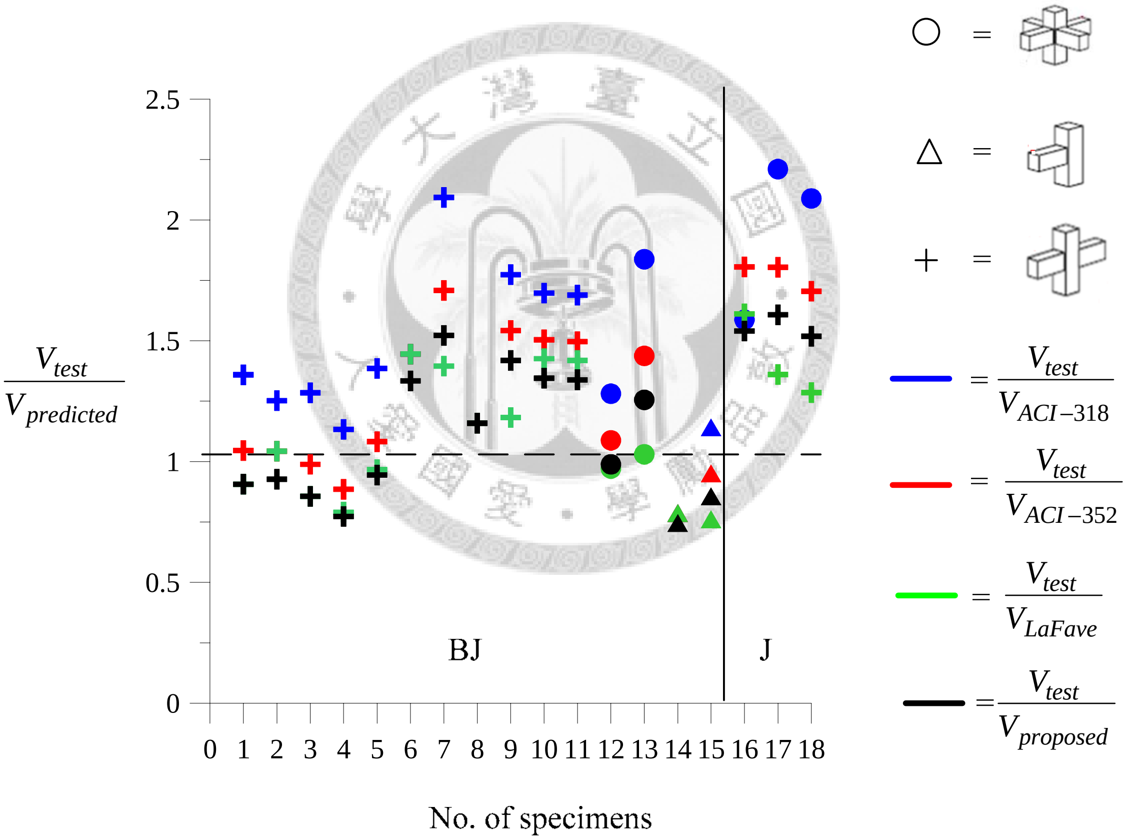
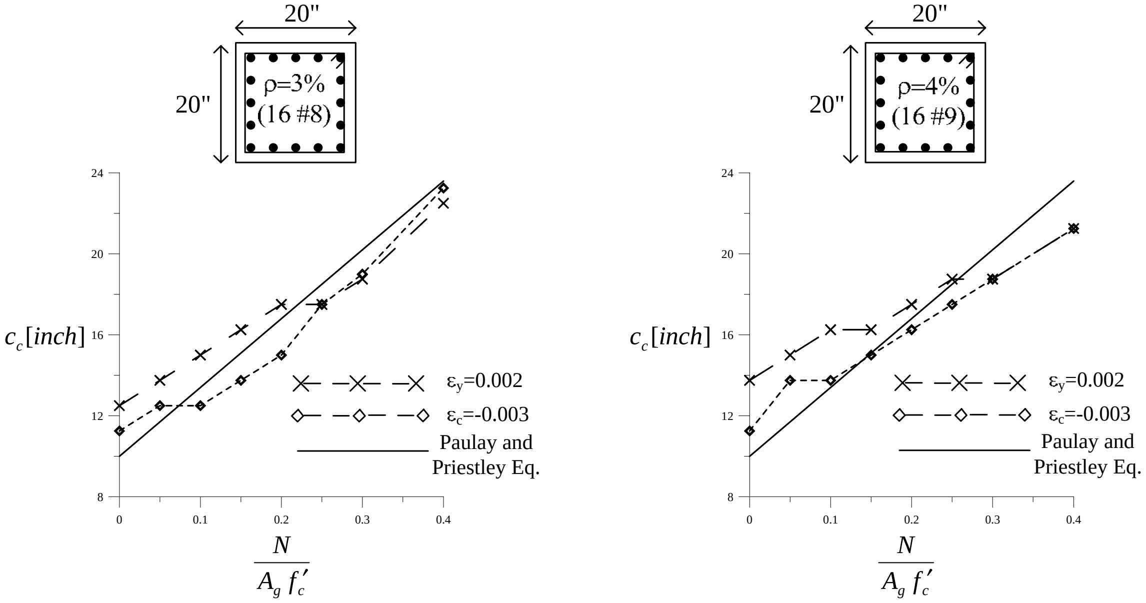
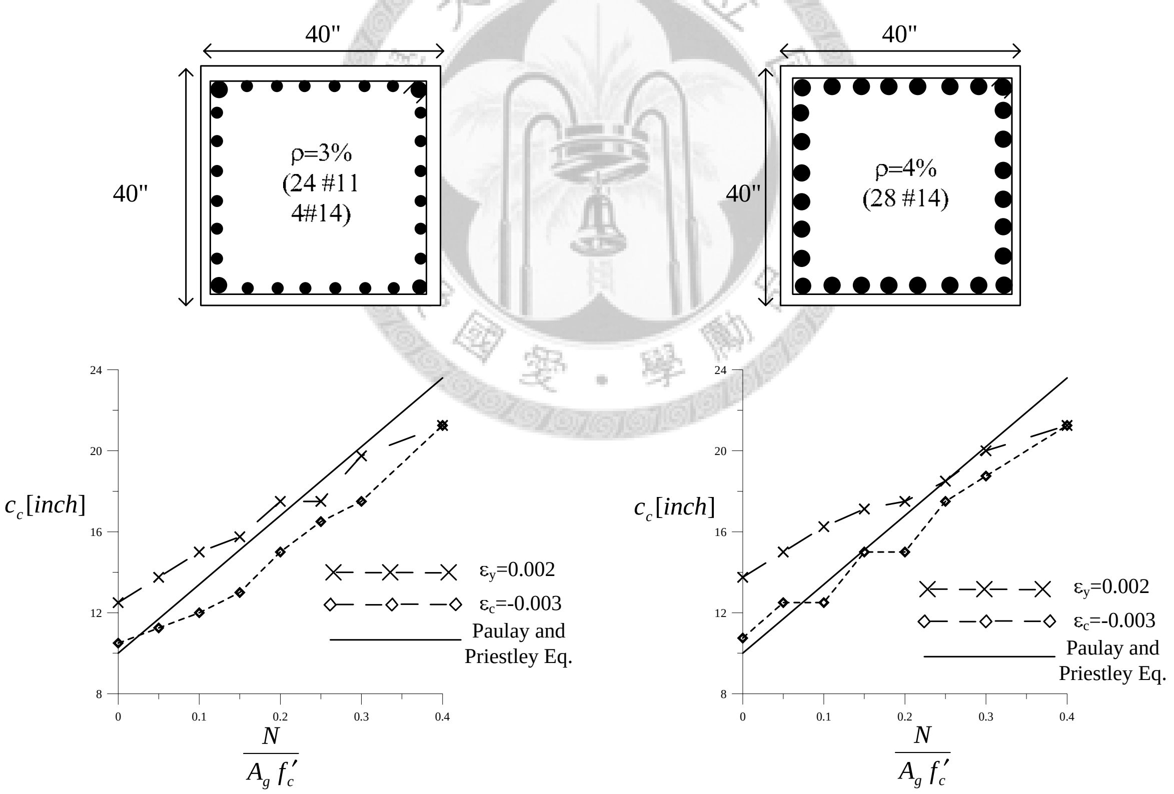


Figure 5-3 — Joint shear strength ratio vs no of specimens for eccentric joints



(a) — Sensitivity analysis on Paulay and Priestley Equation for 20"x20" column with ρ=3%

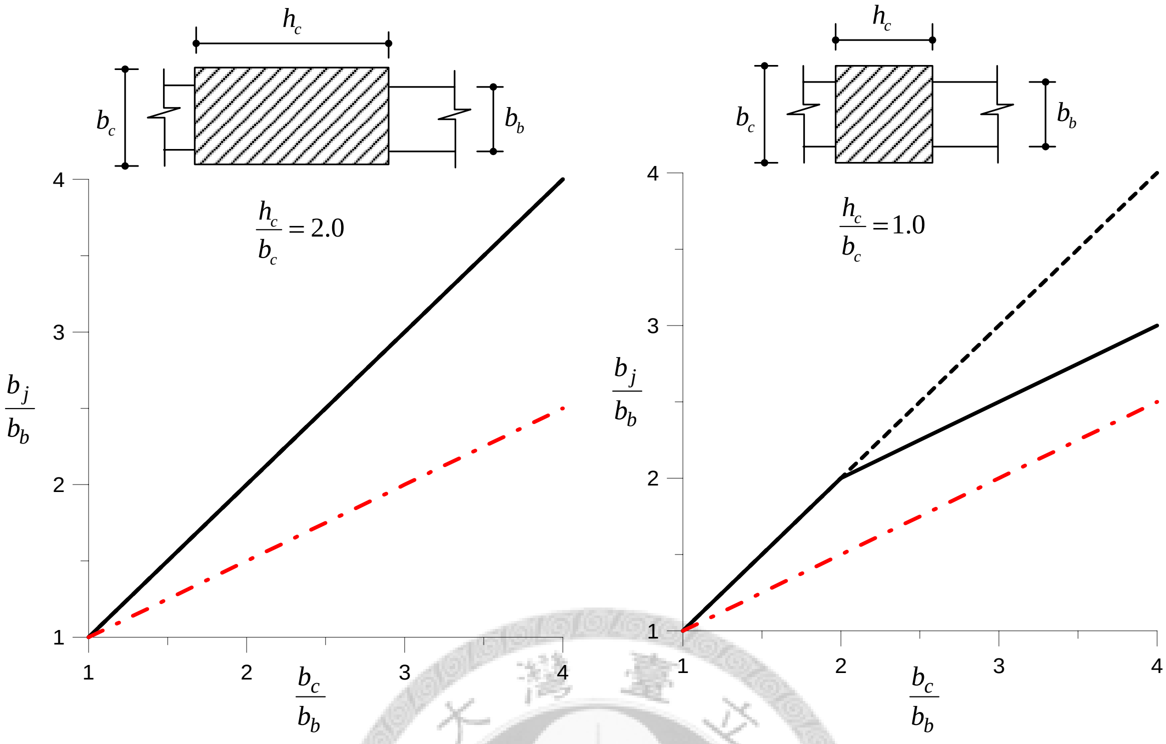
(b) — Sensitivity analysis on Paulay and Priestley Equation for 20"x20" column with ρ=4%



(c) — Sensitivity analysis on Paulay and Priestley Equation for 40"x40" column with ρ=3%

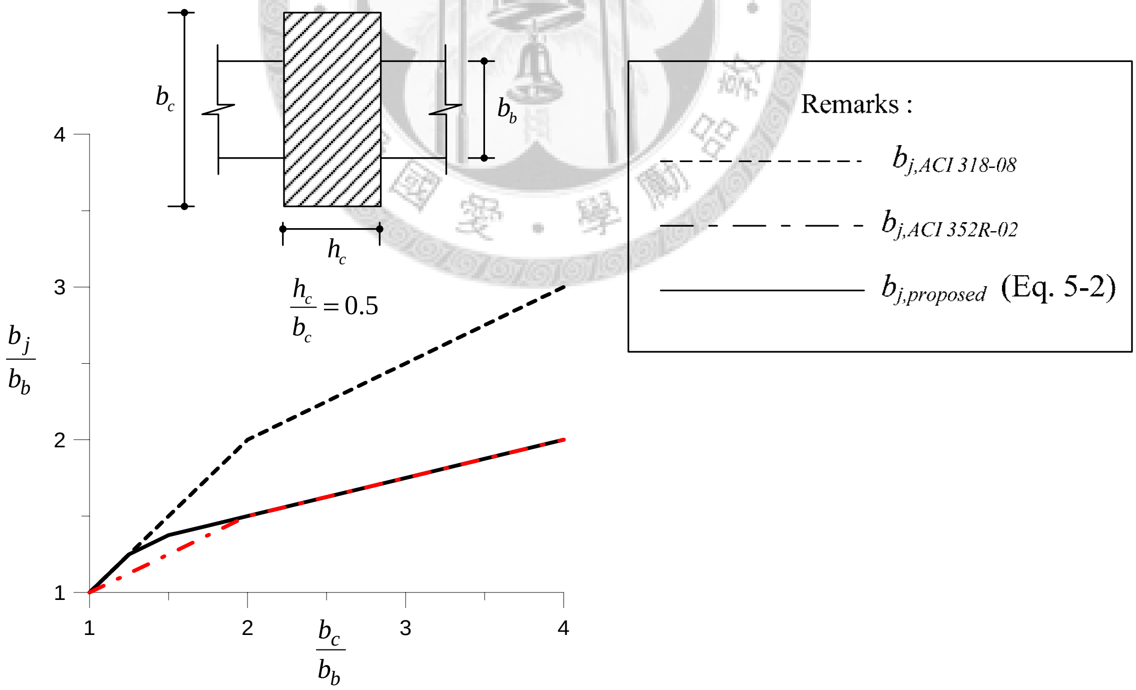
(d) — Sensitivity analysis on Paulay and Priestley Equation for 40"x40" column with ρ=4%

Figure 5-4 — Sensitivity analysis on Paulay and Priestley Equation with varying axial load ratio



(a) — Sensitivity analysis for different definitions of b_j for rectangular column loaded in strong axis

(b) — Sensitivity analysis for different definitions of b_j for square column



(a) — Sensitivity analysis for different definitions of b_j for rectangular column loaded in weak axis

Fig. 5-5 — Sensitivity analysis for different definitions of b_j

APPENDIX A

Table A1 — Database storage for eccentric beam-column joints (1/17)

No. ID	Authors	Spec. ID	Column Dimension							
			Upper Column		Lower Column		b_c[mm]	h_c[mm]	Cover-x [mm]	Cover-y [mm]
			L_column_u [mm]	f_c'[MPa]	L_column_lw [mm]	f_c'[MPa]				
Je-1	Joh et al. (1991)	JX0-B5	875	27.05	875	23.03	300.00	300.00	30	30
RW-1	Raffaelle and Wight (1995)	S1	1066	28.61	1168	28.61	355.60	355.60	25	25
RW-2		S2	1066	26.82	1168	26.82	355.60	355.60	25	25
RW-3		S3	1066	37.71	1168	37.71	355.60	355.60	25	25
RW-4		S4	1066	19.31	1168	19.31	355.60	355.60	25	25
TZ-1	Teng and Zhou (2003)	S2	1313	34.00	1313	34.00	400.00	300.00	30	30
TZ-2		S3	1313	35.00	1313	35.00	400.00	300.00	30	30
TZ-3		S5	1313	39.00	1313	39.00	400.00	200.00	30	30
TZ-4		S6	1313	38.00	1313	38.00	400.00	200.00	30	30
SL-1	Shin and LaFave (2004)	S1	1473	35.8	1473	29.90	457.00	330.00	30	30
SL-2		S2	1473	40.7	1473	36.20	457.00	330.00	30	30
GJ-1	Goto and Joh (2004)	UM-60	875	24.60	875	24.60	450.00	300.00	30	30
GJ-2		UM-125	875	25.20	875	25.20	450.00	300.00	30	30
GJ-3		UU-125	875	25.40	875	25.40	450.00	300.00	30	30
Ke-1	Kusuhara et al. (2004)	JE-55	735	27.00	735	27.00	320.00	280.00	33	33
Ke-2		JE-55S	735	27.00	735	27.00	320.00	280.00	33	33
LK-1	Lee and Ko (2007)	W75	1350	25.20	1350	30.40	600.00	400.00	50	50
LK-2		W150	1350	25.20	1350	29.10	600.00	400.00	50	50

Table A1 — Database storage for eccentric beam-column joints (2/17)

No. ID	Arrangement of Column Longitudinal Reinforcement-1																		
	1st layer							2nd layer				3rd layer				4th layer			
		Corner bar			Intermediate Bar			Side Bar				Side Bar				Side Bar			
	d_1 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	d_2 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_3 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_4 [mm]	n	d_{bar} [mm]	f_y [MPa]
Je-1	270.00	2	13	370	1	13	370	150	2	13	370	0	0	0	0	0	0	0	0
RW-1	330.20	2	19.10	441	1	19	441	178	2	19	441	0	0	0	0	0	0	0	0
RW-2	330.20	2	19.10	441	1	19	441	178	2	19	441	0	0	0	0	0	0	0	0
RW-3	330.20	2	19.10	441	1	19	441	178	2	19	441	0	0	0	0	0	0	0	0
RW-4	330.20	2	19.10	441	1	19	441	178	2	19	441	0	0	0	0	0	0	0	0
TZ-1	270.00	2	20.00	530	3	20	530	150	2	20	530	0	0	0	0	0	0	0	0
TZ-2	270.00	2	20.00	530	3	20	530	150	2	20	530	0	0	0	0	0	0	0	0
TZ-3	170.00	2	20.00	530	3	20	530	100	2	20	530	0	0	0	0	0	0	0	0
TZ-4	170.00	2	20.00	530	3	20	530	100	2	20	530	0	0	0	0	0	0	0	0
SL-1	300	2	19.1	539	1	19	539	100	2	19	539	0	0	0	0	0	0	0	0
SL-2	300	2	19.1	539	1	19	539	100	2	19	539	0	0	0	0	0	0	0	0
GJ-1	270.00	2	16.00	384	4	16	384	150	2	16	384	0	0	0	0	0	0	0	0
GJ-2	270.00	2	16.00	384	4	16	384	150	2	16	384	0	0	0	0	0	0	0	0
GJ-3	270.00	2	16.00	384	4	16	384	150	2	16	384	0	0	0	0	0	0	0	0
Ke-1	247.00	2	13.00	345	4	13	345	174	2	13	345	101	2	13	345	0	0	0	0
Ke-2	247.00	2	13.00	345	4	13	345	174	2	13	345	101	2	13	345	0	0	0	0
LK-1	350	2	22	455	3	22	455	200	2	22	455	0	0	0	0	0	0	0	0
LK-2	350	2	22	455	3	22	455	200	2	22	455	0	0	0	0	0	0	0	0

Table A1 — Databank storage for eccentric beam-column joints (3/17)

No. ID	Arrangement of Column Longitudinal Reinforcement														
	5th layer				6th layer				7th layer						
	Side Bar				Side Bar					Corner Bar			Intermediate Bar		
	d_5 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_6 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_7 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
Je-1	0	0	0	0	0	0	0	0	30	2	13	370	1	13	370
RW-1	0	0	0	0	0	0	0	0	25	2	19.10	441	1	19	441
RW-2	0	0	0	0	0	0	0	0	25	2	19.10	441	1	19	441
RW-3	0	0	0	0	0	0	0	0	25	2	19.10	441	1	19	441
RW-4	0	0	0	0	0	0	0	0	25	2	19.10	441	1	19	441
TZ-1	0	0	0	0	0	0	0	0	30	2	20.00	530	3	20	530
TZ-2	0	0	0	0	0	0	0	0	30	2	20.00	530	3	20	530
TZ-3	0	0	0	0	0	0	0	0	30	2	20.00	530	3	20	530
TZ-4	0	0	0	0	0	0	0	0	30	2	20.00	530	3	20	530
SL-1	0	0	0	0	0	0	0	0	30	2	19.1	539	1	19	539
SL-2	0	0	0	0	0	0	0	0	30	2	19.1	539	1	19	539
GJ-1	0	0	0	0	0	0	0	0	30	2	16.00	384	4	16	384
GJ-2	0	0	0	0	0	0	0	0	30	2	16.00	384	4	16	384
GJ-3	0	0	0	0	0	0	0	0	30	2	16.00	384	4	16	384
Ke-1	0	0	0	0	0	0	0	0	33	2	13.00	345	4	13	345
Ke-2	0	0	0	0	0	0	0	0	33	2	13.00	345	4	13	345
LK-1	0	0	0	0	0	0	0	0	50	2	22	455	3	22	455
LK-2	0	0	0	0	0	0	0	0	50	2	22	455	3	22	455

Table A1 — Database storage for eccentric beam-column joints (4/17)

No. ID	Transverse Reinforcement - 1														
	Type of Hz. Reinf.	Column 1^{st} section (closer to joint)													
		Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
				n-set	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
Je-1	I	whole	50	1	10	307	0	0	0	0	0	0	0	0	0
RW-1	VI	whole	65	1	10	476	0	0	0	0	0	0	1	10	476
RW-2	VI	whole	65	1	10	476	0	0	0	0	0	0	1	10	476
RW-3	VI	whole	65	1	10	476	0	0	0	0	0	0	1	10	476
RW-4	VI	whole	65	1	10	476	0	0	0	0	0	0	1	10	476
TZ-1	I	whole	75	1	10	440	0	0	0	0	0	0	0	0	0
TZ-2	I	whole	75	1	10	440	0	0	0	0	0	0	0	0	0
TZ-3	I	whole	50	1	10	440	0	0	0	0	0	0	0	0	0
TZ-4	I	whole	50	1	10	440	0	0	0	0	0	0	0	0	0
SL-1	III	whole	83	1	10	448	1	10	448	1	10	448	0	0	0
SL-2	III	whole	83	1	10	448	1	10	448	1	10	448	0	0	0
GJ-1	I	whole	50	1	6	355	0	0	0	0	0	0	0	0	0
GJ-2	I	whole	50	1	6	355	0	0	0	0	0	0	0	0	0
GJ-3	I	whole	50	1	6	355	0	0	0	0	0	0	0	0	0
Ke-1	I	whole	50	1	6	364	0	0	0	0	0	0	0	0	0
Ke-2	I	whole	50	1	6	364	0	0	0	0	0	0	0	0	0
LK-1	III	whole	100	1	10	455	3	10	100	1	10	455	0	0	0
LK-2	III	whole	100	1	10	455	3	10	100	1	10	455	0	0	0

Table A1 — Database storage for eccentric beam-column joints (5/17)

No.ID	Transverse Reinforcement -2													
	Column 2nd section (closer to column end)													
	Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
			n-set	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
Je-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ke-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ke-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 — Database storage for eccentric beam-column joints (6/17)

No. ID	ecc. [mm]	Beam Dimension							
		Left Beam		Right Beam		b_b[mm]	h_b[mm]	cover-x[mm]	cover-y[mm]
		f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
Je-1	75	23.03	1500	23.03	1500	150	350	30	30
RW-1	50.8	28.61	2267	28.61	2267	254	381	25.4	25.4
RW-2	88.9	26.82	2267	26.82	2267	177.8	381	25.4	25.4
RW-3	82.55	37.711	2267	37.711	2267	190.5	381	25.4	25.4
RW-4	82.55	19.30	2267	19.30	2267	190.5	558.8	25.4	25.4
TZ-1	50	34.00	2000	34.00	2000	200	400	30	30
TZ-2	100	35.00	2000	35.00	2000	200	400	30	30
TZ-3	50	39.00	2000	39.00	2000	200	400	30	30
TZ-4	100	38.00	2000	38.00	2000	200	400	30	30
SL-1	89	29.90	2336	29.90	2336	279	406	30	30
SL-2	140	36.20	2336	36.20	2336	178	406	30	30
GJ-1	60	24.60	1500	24.60	1500	200	350	30	30
GJ-2	125	25.20	1500	25.20	1500	200	350	30	30
GJ-3	125	25.40	1500	25.40	1500	200	350	30	30
Ke-1	55	28.70	1350	28.70	1350	180	300	33	33
Ke-2	55	28.70	1350	28.70	1350	180	300	33	33
LK-1	75	25.20	2075	0	0	300	450	50	50
LK-2	150	25.20	2075	0	0	300	450	50	50

Table A1 — Database storage for eccentric beam-column joints (7/17)

No. ID	Arrangement of Beam Longitudinal Reinforcement-1																				
	1st layer										2nd layer							3rd layer			
	d_1 [mm]	Corner bar			Intermediate Bar			Inner Bar			d_2 [mm]	Outer bar			Inner Bar			d_3 [mm]	Outer + Inner Bar		
		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$
Je-1	320	2	13	370.44	1	13	370.44	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-1	355.6	2	15.9	448.16	1	15.9	448.1615	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-2	355.6	2	15.9	448.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-3	355.6	2	15.9	448.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-4	533.4	2	15.9	448.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-1	370	2	16	510	1	16	510	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-2	370	2	16	510	1	16	510	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-3	370	2	13	425	1	13	425	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-4	370	2	13	425	1	13	425	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-1	376	2	15.9	506	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-2	376	2	15.9	506	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-1	320	2	22	697	1	22	697	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-2	320	2	22	697	1	22	697	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-3	320	2	22	697	1	22	697	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ke-1	267	2	10	359	3	10	359	0	0	0	232	2	10	359	3	10	359	0	0	0	0
Ke-2	267	2	10	359	3	10	359	0	0	0	232	2	10	359	3	10	359	0	0	0	0
LK-1	400	2	22	455	2	22	455	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	400	2	22	455	2	22	455	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 — Database storage for eccentric beam-column joints (8/17)

No. ID	Arrangement of Beam Longitudinal Reinforcement-2														
	4th layer				5th layer				6th layer						
	d_4	Outer+Inner bar			d_5	Outer+Inner bar			d_6	Outer Bars			Inner Bar		
	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$
Je-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-1	0	0	0	0	0	0	0	0	60	2	16	510	0	0	0
TZ-2	0	0	0	0	0	0	0	0	60	2	16	510	0	0	0
TZ-3	0	0	0	0	0	0	0	0	60	2	13	425	0	0	0
TZ-4	0	0	0	0	0	0	0	0	60	2	13	425	0	0	0
SL-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-2	0	0	0	0	0	0	0	0	60	2	15.9	506	0	0	0
GJ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ke-1	0	0	0	0	0	0	0	0	68	2	10	359	3	10	359
Ke-2	0	0	0	0	0	0	0	0	68	2	10	359	3	10	359
LK-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 — Database storage for eccentric beam-column joints (9/17)

No. ID	Beam Longitudinal Reinforcement-3									
	7th layer									
	d_7 [mm]	Corner bar			Intermediate Bar			Inner Bar		
		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
Je-1	30	2	13	370.44	1	13	370.44	0	0	0
RW-1	25	2	15.9	448.16	1	15.9	448.1615	0	0	0
RW-2	25	2	15.9	448.16	0	0	0	0	0	0
RW-3	25	2	15.9	448.16	0	0	0	0	0	0
RW-4	25	2	15.9	448.16	0	0	0	0	0	0
TZ-1	30	2	16	510	1	16	510	0	0	0
TZ-2	30	2	16	510	1	16	510	0	0	0
TZ-3	30	2	13	425	1	13	425	0	0	0
TZ-4	30	2	13	425	1	13	425	0	0	0
SL-1	30	2	15.9	506	0	0	0	0	0	0
SL-2	30	2	15.9	506	0	0	0	0	0	0
GJ-1	30	2	22	697	1	22	697	0	0	0
GJ-2	30	2	22	697	1	22	697	0	0	0
GJ-3	30	2	22	697	1	22	697	0	0	0
Ke-1	33	2	10	359	3	10	359	0	0	0
Ke-2	33	2	10	359	3	10	359	0	0	0
LK-1	50	2	22	455	2	22	455	0	0	0
LK-2	50	2	22	455	2	22	455	0	0	0

Table A1 — Database storage for eccentric beam-column joints (10/17)

No. ID	Beam Transverse Reinf.													
	Section-1							Section-2						
	Length [mm]	s_{hz_1} [mm]	f_y [MPa]	Stirrup		Vert. Ties		Length [mm]	s_{hz_2} [mm]	f_y [MPa]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
Je-1	whole	150	306.74	2	9	0	0	0	0	0	0	0	0	0
RW-1	406.4	82.55	475.74	2	6	0	0	1861	165	475.74	2	6	0	0
RW-2	406.4	82.55	475.74	2	6	0	0	1861	165	475.74	2	6	0	0
RW-3	406.4	82.55	475.74	2	6	0	0	1861	165	475.74	2	6	0	0
RW-4	406.4	82.55	475.74	2	6	0	0	1861	165	475.74	2	6	0	0
TZ-1	whole	100	440	2	10	0	0	0	0	0	0	0	0	0
TZ-2	whole	100	440	2	10	0	0	0	0	0	0	0	0	0
TZ-3	whole	100	440	2	10	0	0	0	0	0	0	0	0	0
TZ-4	whole	100	440	2	10	0	0	0	0	0	0	0	0	0
SL-1	whole	83	448	2	10	0	0	0	0	0	0	0	0	0
SL-2	whole	83	448	2	10	0	0	0	0	0	0	0	0	0
GJ-1	whole	50	355	2	6	1	6	0	0	0	0	0	0	0
GJ-2	whole	50	355	2	6	1	6	0	0	0	0	0	0	0
GJ-3	whole	50	355	2	6	1	6	0	0	0	0	0	0	0
Ke-1	whole	50	364	2	6	0	0	0	0	0	0	0	0	0
Ke-2	whole	50	364	2	6	0	0	0	0	0	0	0	0	0
LK-1	whole	100	455	2	10	2	10	0	0	0	0	0	0	0
LK-2	whole	100	455	2	10	2	10	0	0	0	0	0	0	0

Table A1 — Database storage for eccentric beam-column joints (11/17)

No. ID	Joint Dimension				Joint Transverse Reinforcement - 1								
	b_{jt}[mm]	h_{jt}[mm]	d_{jt}[mm]	f_c'[MPa]	Type of Hz. Reinf.	No. of joint set	$s_{vert.}$	Outer hoop			Ties in X-dir		
								n-set	d_{bar}	f_y[MPa]	n-set	d_{bar}	f_y[MPa]
Je-1	300.00	300.00	290	23.03	I	3	87.5	1	6	307	0	0	0
RW-1	355.60	355.60	330	28.61	VI	3	89	1	9.53	476	0	0	0
RW-2	355.60	355.60	330	26.82	VI	3	89	1	9.53	476	0	0	0
RW-3	355.60	355.60	330	37.71	VI	3	89	1	9.53	476	0	0	0
RW-4	355.60	355.60	508	19.31	VI	5	89	1	9.53	476	0	0	0
TZ-1	400.00	300.00	340	34.00	III	4	75	1	10	440	1	10	440
TZ-2	400.00	300.00	340	35.00	III	4	75	1	10	440	1	10	440
TZ-3	400.00	200.00	340	39.00	III	4	50	1	10	440	1	10	440
TZ-4	400.00	200.00	340	38.00	III	4	50	1	10	440	1	10	440
SL-1	457.00	330.00	346	29.90	III	3	83	1	9.53	448	1	10	448
SL-2	457.00	330.00	346	36.20	III	3	83	1	9.53	448	1	10	448
GJ-1	450.00	300.00	290	24.60	I	6	50	1	6	355	0	0	0
GJ-2	450.00	300.00	290	25.20	I	7	50	1	6	355	0	0	0
GJ-3	450.00	300.00	290	25.40	I	7	25	1	6	355	0	0	0
Ke-1	320.00	280.00	234	27.00	I	3	82	1	6	364	0	0	0
Ke-2	320.00	280.00	234	27.00	I	5	41	1	6	364	0	0	0
LK-1	600.00	400.00	350	30.40	III	3	100	1	10	455	3	10	455
LK-2	600.00	400.00	350	29.10	III	3	100	1	10	455	3	10	455

Table A1 — Database of eccentric beam-column joints (12/17)

No. ID	Joint Transverse Reinforcement -2						Provided Reinf		Code req		$\frac{A_{sh\_prov}}{A_{sh\_req}}$
	Ties in Y Direction			Diagonal Ties			Ash-x [%]	Ash-y [%]	Ash-x [%]	Ash-y [%]	
	n-set	d_{bar} [mm]	f_y[MPa]	n-set	d_{bar}[mm]	f_y[MPa]					
Je-1	0	0	0	0	0	0	0.20	0.20	0.67	0.67	0.36
RW-1	0	0	0	1	9.53	476	0.90	0.90	0.65	0.65	1.38
RW-2	0	0	0	1	9.53	476	0.90	0.90	0.61	0.61	1.47
RW-3	0	0	0	1	9.53	476	0.90	0.90	0.86	0.86	1.04
RW-4	0	0	0	1	9.53	476	0.90	0.90	0.44	0.44	2.04
TZ-1	0	0	0	0	0	0	0.92	0.87	1.10	1.10	0.85
TZ-2	0	0	0	0	0	0	0.92	0.87	1.12	1.12	0.82
TZ-3	0	0	0	0	0	0	1.35	2.10	1.42	1.42	0.95
TZ-4	0	0	0	0	0	0	1.35	2.10	1.38	1.38	0.97
SL-1	1	9.53	448	0	0	0	0.7	1.0	0.67	0.67	1.03
SL-2	1	9.53	448	0	0	0	0.7	1.0	0.82	0.82	0.85
GJ-1	0	0	0	0	0	0	0.28	0.45	0.73	0.73	0.39
GJ-2	0	0	0	0	0	0	0.28	0.45	0.74	0.74	0.38
GJ-3	0	0	0	0	0	0	0.56	0.90	0.75	0.75	0.75
Ke-1	0	0	0	0	0	0	0.27	0.32	1.44	1.44	0.19
Ke-2	0	0	0	0	0	0	1.27	0.64	1.44	1.44	0.88
LK-1	1	10	455	0	0	0	0.72	0.70	0.50	0.50	1.45
LK-2	1	10	455	0	0	0	0.72	0.70	0.50	0.50	1.45

Table A1 — Database storage for eccentric beam-column joints (13/17)

No. ID	TB horizontal relative position to main beam	TB vertical relative position to main beam	Transverse Beam Dimension							
			North Beam		South Beam		b_{tb}[mm]	h_{tb}[mm]	Cover-x[mm]	Cover-y[mm]
			f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
Je-1	0	0	0	0	0	0	0	0	0	0
RW-1	0	0	0	0	0	0	0	0	0	0
RW-2	0	0	0	0	0	0	0	0	0	0
RW-3	0	0	0	0	0	0	0	0	0	0
RW-4	0	0	0	0	0	0	0	0	0	0
TZ-1	0	0	0	0	0	0	0	0	0	0
TZ-2	0	0	0	0	0	0	0	0	0	0
TZ-3	0	0	0	0	0	0	0	0	0	0
TZ-4	0	0	0	0	0	0	0	0	0	0
SL-1	0	0	0	0	29.90	1200	330	406	30	30
SL-2	0	0	0	0	36.20	1200	330	406	30	30
GJ-1	0	0	0	0	0	0	0	0	0	0
GJ-2	0	0	0	0	0	0	0	0	0	0
GJ-3	0	0	0	0	0	0	0	0	0	0
Ke-1	0	0	0	0	0	0	0	0	0	0
Ke-2	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0

Table A1 — Database storage for eccentric beam-column joints (14/17)

No. ID	Arrangement of Transverse Beam Longitudinal Reinforcement-1																	
	1st layer							2nd layer				3rd layer						
	d_1 [mm]	Outer bar			Inner Bar			Side Bar				d_3 [mm]	Outer Bar			Inner Bar		
		n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	d_2 [mm]	n	d_{bar}	f_y [MPa]		n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
Je-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-1	376	2	15.9	506	0	0	0	0	0	0	0	30	2	15.9	506	0	0	0
SL-2	376	2	15.9	506	0	0	0	0	0	0	0	30	2	15.9	506	0	0	0
GJ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ke-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ke-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 — Database storage for eccentric beam-column joints (15/17)

No. ID	Beam Transverse Reinf.						
	Whole Section						
	Length [mm]	f_y [MPa]	s_{hz}[mm]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
Je-1	0	0	0	0	0	0	0
RW-1	0	0	0	0	0	0	0
RW-2	0	0	0	0	0	0	0
RW-3	0	0	0	0	0	0	0
RW-4	0	0	0	0	0	0	0
TZ-1	0	0	0	0	0	0	0
TZ-2	0	0	0	0	0	0	0
TZ-3	0	0	0	0	0	0	0
TZ-4	0	0	0	0	0	0	0
SL-1	whole	448	83	2	9.53	0	0
SL-2	whole	448	83	2	9.53	0	0
GJ-1	0	0	0	0	0	0	0
GJ-2	0	0	0	0	0	0	0
GJ-3	0	0	0	0	0	0	0
Ke-1	0	0	0	0	0	0	0
Ke-2	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0

Table A1 — Database storage for eccentric beam-column joints (16/17)

No.ID	Dimension						Reinforcement							
	thickness	f’c	Along loading-dir		Perpendicular to loading dir		Along loading-direction				Perpendicular to loading-direction			
			L_{slab_left} [mm]	L_{slab_right} [mm]	L_{slab_north} [mm]	L_{slab_south} [mm]	Top Reinf		Bot Reinf.		Top Reinf		Bot Reinf.	
							d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]
Je-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RW-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TZ-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SL-1	102	29.90	2337	2337	1200	0	9.53	254	0	0	9.53	254	0	0
SL-2	102	36.20	2337	2337	1200	0	9.53	254	0	0	9.53	254	0	0
GJ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GJ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ke-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ke-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 — Database storage for eccentric beam-column joints (17/17)

No. ID	Failure Mode	Column axial load [%Agf’c]	Maximum Loading				Loading Curve								
			Positive		Negative		Type of Loading	Positive Loading				Negative Loading			
			P_{max}[kN]	Drift[%]	P_{max}[kN]	Drift[%]		$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$	$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$
Je-1	BJ	12.70	64.00	3.30	58.00	1.90	I	40.9	48.8	62.5	61.7	34	51.2	54.3	51.4
RW-1	BJ	2.50	96.50	4.00	97.90	4.00	I	31.2	46.9	85.0	95.5	25.1	44.2	75.2	91.7
RW-2	BJ	2.60	65.00	3.00	62.30	3.00	I	31.4	42.0	60.3	64.2	22.3	39.4	56.7	58.8
RW-3	BJ	1.86	77.50	4.00	66.75	3.80	I	34.0	52.0	65.0	76.0	21.4	38.5	56.7	64.2
RW-4	BJ	3.64	102.50	3.00	102.35	3.00	I	46.3	71.6	99.1	102.0	36.5	60.5	92.3	90.0
TZ-1	BJ	10.80	120.00	2.70	110.00	2.60	I	48.7	68.7	112.0	113.0	46.7	76.1	107.0	105.0
TZ-2	BJ	10.50	115.00	2.70	110.00	2.80	I	42.4	61.2	93.6	97.0	42.4	69.6	105.0	98.8
TZ-3	BJ	11.00	73.00	2.90	68.00	2.80	I	34.0	45.4	67.6	70.0	28.0	43.0	64.0	67.0
TZ-4	BJ	11.30	70.00	2.60	66.00	2.80	I	27.0	37.0	55.5	66.4	28.0	42.5	62.2	65.8
SL-1	BJ	0	84.55	3.00	82.33	4.00	I	26.8	45.0	70.1	87.7	29.0	44.6	69.5	81.0
SL-2	BJ	0	82.77	3.90	81.44	3.10	I	28.7	45.6	70.1	83.0	31.0	45.0	71.7	81.4
GJ-1	J	16.67	160.00	4.00	149.00	4.00	I	81.1	118.0	145.0	158.0	84.5	117.0	143.0	147.0
GJ-2	J	16.67	140.00	2.90	125.00	2.80	I	81.0	111.0	130.0	135.0	83.3	107.0	126.0	124.0
GJ-3	J	16.67	130.00	4.10	119.00	2.80	I	80.0	105.0	124.0	128.0	75.0	100.0	118.0	120.0
Ke-1	BJ	0	88.90	3.00	82.50	1.60	I	43.2	77.8	86.7	79.0	41.1	66.0	83.0	70.0
Ke-2	BJ	0	91.50	3.20	84.00	2.00	I	47.0	72.5	90.0	89.0	31.0	57.0	87.5	78.6
LK-1	BJ	10	170.00	5.00	171.00	4.30	III	111.7	141.0	154.3	169.0	59.0	122.0	169.0	154.3
LK-2	BJ	10	154.35	4.00	147.00	4.00	III	95.5	132.3	147.0	132.3	72.0	117.6	132.3	125.0

Table A2 — Database storage for concentric-interior beam-column joints (1/51)

No. ID	Authors	Spec. ID	Column Dimension							
			Upper Column		Lower Column		b_c[mm]	h_c[mm]	Cover-x [mm]	Cover-y [mm]
			L_column_u [mm]	f_c'[MPa]	L_column_lw [mm]	f_c'[MPa]				
H-1	Hanson(1971)	S1	1524	38.89	1524	38.89	381.00	381.00	56.00	56.00
H-2	Hanson(1971)	S2	1524	33.85	1524	33.85	381.00	381.00	56.00	56.00
MJ-1	Meinheit and Jirsa (1977)	SI	1829	26.20	1829	26.20	330.20	457.20	67	67
MJ-2		SII	1829	41.78	1829	41.78	330.20	457.20	67	67
MJ-3		SIII	1829	26.61	1829	26.61	330.20	457.20	67	67
MJ-4		SIV	1829	36.06	1829	36.06	457.20	330.20	67	67
MJ-5		SV	1829	35.85	1829	35.85	330.20	457.20	67	67
MJ-6		SVI	1829	36.75	1829	36.75	330.20	457.20	67	67
MJ-7		SVII	1829	37.23	1829	37.23	457.20	330.20	67	67
MJ-8		SVIII	1829	33.10	1829	33.10	330.20	457.20	66.90	66.90
MJ-9		SIX	1829	31.03	1829	31.03	330.20	457.20	66.90	66.90
MJ-10		SX	1829	29.58	1829	29.58	330.20	457.20	66.90	66.90
MJ-11		SXI	1829	25.65	1829	25.65	457.20	330.20	66.90	66.90
MJ-12		SXII	1829	35.16	1829	35.16	330.20	457.20	67	67
MJ-13		SXIII	1829	41.30	1829	41.30	330.20	457.20	67	67
MJ-14		SXIV	1829	33.16	1829	33.16	457.20	330.20	67	67
FI-1	Fenwick and Irvine (1977)	Unit 1	1830	42.90	1830	42.90	250.00	300.00	30	30
FI-2		Unit 3	1830	39.30	1830	39.30	250.00	300.00	30	30

Table A2 — Database storage for concentric-interior beam-column joints (2/51)

No. ID	Authors	Spec. ID	Column Dimension							
			Upper Column		Lower Column					
			L_column_u [mm]	f_c'[MPa]	L_column_lw [mm]	f_c'[MPa]	b_c[mm]	h_c[mm]	Cover-x [mm]	Cover-y [mm]
B-1	Birss (1978)	B1	1715	27.90	1715	27.90	457.00	457.00	43	43
B-2		B2	1715	31.50	1715	31.50	457.00	457.00	43	43
Ve-1	Viwathanepa et al. (1979)	BC3	914	31.11	914	31.11	431.8	431.8	19	19
Ve-2		BC4	914	32.11	914	32.11	431.8	431.8	19	19
Bck-1	Beckingsale (1980)	B11	1677	34.70	1677	34.7	457.0	457.0	43	43
Bck-2		B12	1677	34.20	1677	34.2	457.0	457.0	43	43
Bck-3		B13	1677	28.90	1677	28.9	457.0	457.0	43	43
Pe-1	Park et al. (1981)	Unit 1	1665	34.00	1665	34	305.0	406.0	40	40
R-1	Rabbat (1982)	NC1	1524	36.82	1524	36.82	381.00	381.00	59	59
R-2		NC2	1524	35.58	1524	35.58	381.00	381.00	59	59
R-3		NC3	1524	32.47	1524	32.47	381.00	381.00	59	59
PM-1	Park and Milburn (1983)	Unit 1	1675	41.30	1675	41.00	305.00	406.00	42	42
PM-2		Unit 2	1675	46.90	1675	46.90	305.00	406.00	42	42
DW5-1	Durrani and Wight (1985)	X1	914	32.51	914	29.27	361.95	361.95	55	55
DW5-2		X2	914	36.09	914	30.85	361.95	361.95	55	55
DW5-3		X3	914	26.96	914	33.03	361.95	361.95	55	55
A-1	Abrams-1987-ACI	LIJ3	1030	31.10	1030	31.10	343.00	457.00	43	43

Table A2 — Database storage for concentric-interior beam-column joints (3/51)

No. ID	Authors	Spec. ID	Column Dimension							
			Upper Column		Lower Column		b_c[mm]	h_c[mm]	Cover-x [mm]	Cover-y [mm]
			L_column_u [mm]	f_c'[MPa]	L_column_lw [mm]	f_c'[MPa]				
DW7-1	Durrani and Wight (1987)	S1	914	29.81	914	29.79	361.95	361.95	76.20	76.20
DW7-2		S2	914	24.82	914	28.27	361.95	361.95	76.20	76.20
DW7-3		S3	914	25.51	914	28.27	361.95	361.95	76.20	76.20
Ge-1	Goto et al. (1988)	HH	875	25.87	875	25.87	300.00	300.00	30	30
Ge-2		HL	875	27.44	875	27.44	300.00	300.00	30	30
Ge-3		MH	875	28.13	875	28.13	300.00	300.00	30	30
Ge-4		LH	875	26.85	875	26.85	300.00	300.00	30	30
L-1	Leon-1990-ACI	BCJ2	1232	27.40	1232	27.40	254.00	254.00	25	25
L-2		BCJ3	1232	27.20	1232	27.20	254.00	254.00	25	25
FA-1	Fujii-1991-SP 123	A1	750	40.18	750	40.18	220.00	220.00	30	30
FA-2		A2	750	40.18	750	40.18	220.00	220.00	30	30
FA-3		A3	750	40.18	750	40.18	220.00	220.00	30	30
FA-4		A4	750	40.18	750	40.18	220.00	220.00	30	30
Ae-1	Au et.al (2003)	E-0.0	1030	43.10	1030	43.10	300.00	300.00	44	44
Ae-2		E-0.3	1030	46.10	1030	46.10	300.00	300.00	44	44
Ae-3		H-0.0	1030	50.60	1030	50.60	300.00	300.00	44	44
Ae-4		H-0.3	1030	45.10	1030	45.10	300.00	300.00	44	44

Table A2 — Database storage for concentric-interior beam-column joints (4/51)

No. ID	Arrangement of Column Longitudinal Reinforcement-1																		
	1st layer							2nd layer				3rd layer				4th layer			
		Corner bar			Intermediate Bar			Side Bar				Side Bar				Side Bar			
	d_1 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	d_3 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	d_4 [mm]	n	d_{bar} [mm]	f_y $[MPa]$
H-1	325.00	2	35.80	417.8244	1	35.80	417.8244	190.50	2	35.60	418	0	0	0	0	0	0	0	0
H-2	325.00	2	35.80	412.3086	1	35.80	412.3086	190.50	2	35.60	412	0	0	0	0	0	0	0	0
MJ-1	390.30	2	22.20	457	0	0.00	0	282.50	2	22.20	457	174.70	2	22.20	457	0.00	0	0.00	0
MJ-2	390.30	2	32.20	449	0	0.00	0	282.50	2	32.20	449	174.70	2	32.20	449	0.00	0	0.00	0
MJ-3	390.30	2	35.80	402	0	0.00	0	309.45	2	35.80	402	228.60	2	35.80	402	148	2	35.80	402
MJ-4	263.30	2	28.70	438	2	28.70	438	165.10	2	28.70	438	0.00	0	0.00	0	0.00	0	0.00	0
MJ-5	390.30	2	32.20	402	0	0.00	0	282.50	2	32.20	402	174.70	2	32.20	402	0.00	0	0.00	0
MJ-6	390.30	2	32.20	402	0	0.00	0	282.50	2	32.20	402	174.70	2	32.20	402	0.00	0	0.00	0
MJ-7	263.30	2	28.70	438	2	28.70	438	165.10	2	28.70	438	0.00	0	0.00	0	0.00	0	0.00	0
MJ-8	390.30	2	32.20	402	0	0.00	0	282.50	2	32.20	402	174.70	2	32.20	402	0	0	0	0
MJ-9	390.30	2	32.20	402	0	0.00	0	282.50	2	32.20	402	174.70	2	32.20	402	0	0	0	0
MJ-10	390.30	2	32.20	402	0	0.00	0	282.50	2	32.20	402	174.70	2	32.20	402	0	0	0	0
MJ-11	263.30	2	28.70	438	2	28.70	438	165.10	2	28.70	438	0.00	0	0.00	0	0	0	0	0
MJ-12	390.30	2	32.20	402	0	0.00	0	282.50	2	32.20	402	174.70	2	32.20	402	0	0.00	0	0
MJ-13	390.30	2	32.20	402	0	0.00	0	282.50	2	32.20	402	174.70	2	32.20	402	0	0.00	0	0
MJ-14	263.30	2	28.70	438	2	28.70	438	165.10	2	28.70	438	0.00	0	0.00	0	0	0.00	0	0
FI-1	270.00	2	20.00	280	2	20.00	280	150.00	2	16.00	280	0.00	0	0.00	0	0.00	0	0.00	0
FI-2	270.00	2	12.00	318	2	12.00	318	240.00	4	12.00	318	60.00	4	12.00	318	0.00	0	0.00	0

Table A2 — Database storage for concentric-interior beam-column joints (5/51)

No. ID	Arrangement of Column Longitudinal Reinforcement-1																		
	1st layer							2nd layer				3rd layer				4th layer			
		Corner bar			Intermediate Bar			Side Bar				Side Bar				Side Bar			
	d_1 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	d_3 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	d_4 [mm]	n	d_{bar} [mm]	f_y $[MPa]$
B-1	414.00	2	24.00	427	2	24.00	427	321.25	2	24.00	427	135.75	2	24.00	427	0.00	0	0.00	0
B-2	414.00	2	24.00	427	2	24.00	427	321.25	2	24.00	427	135.75	2	24.00	427	0.00	0	0.00	0
Ve-1	412.75	2	19.10	490	2	19.10	490	281.52	2	19.10	490	150.29	2	19.10	490	0.00	0	0.00	0
Ve-2	412.75	2	19.10	490	2	19.10	490	281.52	2	19.10	490	150.29	2	19.10	490	0.00	0	0.00	0
Bck-1	414.00	2	22.20	423	2	22.20	423	321.25	2	22.20	423	135.75	2	22.20	423	0.00	0	0.00	0
Bck-2	414.00	2	22.20	423	2	22.20	423	321.25	2	22.20	423	135.75	2	22.20	423	0.00	0	0.00	0
Bck-3	414.00	2	22.20	423	2	22.20	423	321.25	2	22.20	423	135.75	2	22.20	423	0.00	0	0.00	0
Pe-1	366.00	2	20.00	412	0.00	0	0.00	203.00	2	20.00	412	0.00	0	0.00	0	0.00	0	0.00	0
R-1	322.37	2	22.20	459	1	19.10	446	191.87	2	19.10	446	0.00	0	0.00	0	0.00	0	0.00	0
R-2	322.37	2	19.10	437	1	19.10	437	191.87	2	19.10	437	0.00	0	0.00	0	0.00	0	0.00	0
R-3	322.37	2	22.20	444	1	19.10	445	191.87	2	19.10	445	0.00	0	0.00	0	0.00	0	0.00	0
PM-1	364.00	2	24.00	473	0	0	0.00	201.00	2	20.00	412	0.00	0	0.00	0	0.00	0	0.00	0
PM-2	364.00	2	24.00	473	0	0	0.00	201.00	2	20.00	412	0.00	0	0.00	0	0.00	0	0.00	0
DW5-1	306.55	2	25.40	414	1	25.40	414	180.98	2	25.40	414	0.00	0	0.00	0	0.00	0	0.00	0
DW5-2	306.55	2	25.40	414	1	25.40	414	180.98	2	25.40	414	0.00	0	0.00	0	0.00	0	0.00	0
DW5-3	306.55	2	22.20	331	1	19.10	345	180.98	2	19.10	345	0.00	0	0.00	0	0.00	0	0.00	0
A-1	414.00	2	15.90	470	2	15.90	470	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0

Table A2 — Database storage for concentric-interior beam-column joints (6/51)

No. ID	Arrangement of Column Longitudinal Reinforcement-1																		
	1st layer							2nd layer				3rd layer				4th layer			
		Corner bar			Intermediate Bar			Side Bar				Side Bar				Side Bar			
	d_1 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	d_2 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_3 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_4 [mm]	n	d_{bar} [mm]	f_y [MPa]
DW7-1	285.75	2	25.40	413.6875	1	25.40	414	176.66	2	25.40	414	0	0	0	0	0	0	0	0
DW7-2	285.75	2	25.40	413.6875	1	25.40	414	176.66	2	25.40	414	0	0	0	0	0	0	0	0
DW7-3	285.75	2	22.20	330.95	1	22.20	331	176.66	2	22.20	331	0	0	0	0	0	0	0	0
Ge-1	270.00	2	13.00	377	3	13.00	377	190.00	2	13.00	377	110.00	2	13.00	377	0.00	0	0.00	0
Ge-2	270.00	2	13.00	377	3	13.00	377	190.00	2	13.00	377	110.00	2	13.00	377	0.00	0	0.00	0
Ge-3	270.00	2	13.00	377	3	13.00	377	190.00	2	13.00	377	110.00	2	13.00	377	0.00	0	0.00	0
Ge-4	270.00	2	13.00	377	3	13.00	377	190.00	2	13.00	377	110.00	2	13.00	377	0.00	0	0.00	0
L-1	229.00	2	15.90	448	3	12.70	448	178.00	2	12.70	448	127.00	2	12.70	448	76.00	2	12.70	448
L-2	229.00	2	15.90	448	3	12.70	448	178.00	2	12.70	448	127.00	2	12.70	448	76.00	2	12.70	448
FA-1	190.00	2	13.00	643	3	13.00	643	150.00	2	13.00	643	110.00	2	13.00	643	70.00	2	13.00	642.88
FA-2	190.00	2	13.00	387	3	13.00	387	150.00	2	13.00	387	110.00	2	13.00	387	70.00	2	13.00	387.1
FA-3	190.00	2	13.00	643	3	13.00	643	150.00	2	13.00	643	110.00	2	13.00	643	70.00	2	13.00	642.88
FA-4	190.00	2	13.00	643	3	13.00	643	150.00	2	13.00	643	110.00	2	13.00	643	70.00	2	13.00	642.88
Ae-1	256.00	2	16.00	513	3	16.00	513	203.00	2	16.00	513	150.00	2	16.00	513	97.00	2	16.00	513.3
Ae-2	256.00	2	16.00	558	3	16.00	558	203.00	2	16.00	558	150.00	2	16.00	558	97.00	2	16.00	558.4
Ae-3	256.00	2	16.00	595	3	16.00	595	203.00	2	16.00	595	150.00	2	16.00	595	97.00	2	16.00	594.7
Ae-4	256.00	2	16.00	518	3	16.00	518	203.00	2	16.00	518	150.00	2	16.00	518	97.00	2	16.00	518

Table A2 — Database storage for concentric-interior beam-column joints (7/51)

No. ID	Arrangement of Column Longitudinal Reinforcement														
	5th layer				6th layer				7th layer						
	Side Bar				Side Bar					Corner Bar			Intermediate Bar		
	d_5 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_6 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_7 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
H-1	0	0	0	0	0	0	0	0	56.00	2	11.00	417.8244	1	11.00	418
H-2	0	0	0	0	0	0	0	0	56.00	2	11.00	412.3086	1	11.00	412
MJ-1	0	0	0	0	0	0	0	0	66.90	2	22.20	457	0	0.00	0
MJ-2	0	0	0	0	0	0	0	0	66.90	2	32.20	449	0	0.00	0
MJ-3	0	0	0	0	0	0	0	0	66.90	2	35.80	402	0	0.00	0
MJ-4	0	0	0	0	0	0	0	0	66.90	2	28.70	438	2	28.70	438
MJ-5	0	0	0	0	0	0	0	0	66.90	2	32.20	402	0	0.00	0
MJ-6	0	0	0	0	0	0	0	0	66.90	2	32.20	402	0	0.00	0
MJ-7	0	0	0	0	0	0	0	0	66.90	2	28.70	438	2	28.70	438
MJ-8	0	0	0	0	0	0	0	0	66.90	2	32.20	401.9664	0	0.00	0
MJ-9	0	0	0	0	0	0	0	0	66.90	2	32.20	401.9664	0	0.00	0
MJ-10	0	0	0	0	0	0	0	0	66.90	2	32.20	401.9664	0	0.00	0
MJ-11	0	0	0	0	0	0	0	0	66.90	2	28.70	437.8193	2	28.70	438
MJ-12	0	0	0	0	0	0	0	0	66.90	2	32.20	402	0	0.00	0
MJ-13	0	0	0	0	0	0	0	0	66.90	2	32.20	402	0	0.00	0
MJ-14	0	0	0	0	0	0	0	0	66.90	2	28.70	438	2	28.70	438
FI-1	0	0	0	0	0	0	0	0	30.00	2	20.00	280	2	20.00	280
FI-2	0	0	0	0	0	0	0	0	30.00	2	12.00	318	2	12.00	318

Table A2 — Database storage for concentric-interior beam-column joints (8/51)

No. ID	Arrangement of Column Longitudinal Reinforcement														
	5th layer				6th layer				7th layer						
	Side Bar				Side Bar					Corner Bar			Intermediate Bar		
	d_5 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_6 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_7 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
B-1	0	0	0	0	0	0	0	0	43.00	2	24.00	427	2	24.00	427
B-2	0	0	0	0	0	0	0	0	43.00	2	24.00	427	2	24.00	427
Ve-1	0	0	0	0	0	0	0	0	19.05	2	19.10	490	2	19.10	490
Ve-2	0	0	0	0	0	0	0	0	19.05	2	19.10	490	2	19.10	490
Bck-1	0	0	0	0	0	0	0	0	43.00	2	22.20	423	2	22.20	423
Bck-2	0	0	0	0	0	0	0	0	43.00	2	22.20	423	2	22.20	423
Bck-3	0	0	0	0	0	0	0	0	43.00	2	22.20	423	2	22.20	423
Pe-1	0	0	0	0	0	0	0	0	40.00	2	20.00	412	0	0.00	0
R-1	0	0	0	0	0	0	0	0	40.00	2	22.20	459	1	19.10	446
R-2	0	0	0	0	0	0	0	0	40.00	2	19.10	437	1	19.10	437
R-3	0	0	0	0	0	0	0	0	40.00	2	22.20	444	1	19.10	445
PM-1	0	0	0	0	0	0	0	0	40.00	2	24.00	473	0	0.00	0
PM-2	0	0	0	0	0	0	0	0	40.00	2	24.00	473	0	0.00	0
DW5-1	0	0	0	0	0	0	0	0	55.40	2	25.40	414	1	25.40	414
DW5-2	0	0	0	0	0	0	0	0	55.40	2	25.40	414	1	25.40	414
DW5-3	0	0	0	0	0	0	0	0	55.40	2	22.20	331	1	19.10	345
A-1	0	0	0	0	0	0	0	0	43.00	2	15.90	470	2	15.90	470

Table A2 — Database storage for concentric-interior beam-column joints (9/51)

No. ID	Arrangement of Column Longitudinal Reinforcement														
	5th layer				6th layer				7th layer						
	Side Bar				Side Bar					Corner Bar			Intermediate Bar		
	d_5 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_6 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_7 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
DW7-1	0	0	0	0	0	0	0	0	76.20	2	25.40	413.6875	1	25.40	414
DW7-2	0	0	0	0	0	0	0	0	76.20	2	25.40	413.6875	1	25.40	414
DW7-3	0	0	0	0	0	0	0	0	76.20	2	22.20	330.95	1	22.20	331
Ge-1	0	0	0	0	60	2	13	377.3	30.00	2	13.00	377	3	13.00	377
Ge-2	0	0	0	0	60	2	13	377.3	30.00	2	13.00	377	3	13.00	377
Ge-3	0	0	0	0	60	2	13	377.3	30.00	2	13.00	377	3	13.00	377
Ge-4	0	0	0	0	60	2	13	377.3	30.00	2	13.00	377	3	13.00	377
L-1	0	0	0	0	0	0	0	0	25.00	2	15.90	448	2	12.70	448
L-2	0	0	0	0	0	0	0	0	25.00	2	15.90	448	2	12.70	448
FA-1	0	0	0	0	0	0	0	0	30.00	2	13.00	643	3	13.00	643
FA-2	0	0	0	0	0	0	0	0	30.00	2	13.00	387	3	13.00	387
FA-3	0	0	0	0	0	0	0	0	30.00	2	13.00	643	3	13.00	643
FA-4	0	0	0	0	0	0	0	0	30.00	2	13.00	643	3	13.00	643
Ae-1	0	0	0	0	0	0	0	0	44.00	2	16.00	513	3	16.00	513
Ae-2	0	0	0	0	0	0	0	0	44.00	2	16.00	558	3	16.00	558
Ae-3	0	0	0	0	0	0	0	0	44.00	2	16.00	595	3	16.00	595
Ae-4	0	0	0	0	0	0	0	0	44.00	2	16.00	518	3	16.00	518

Table A2 — Database storage for concentric-interior beam-column joints (10/51)

No. ID	Transverse Reinforcement - 1														
	Type of Hz. Reinf.	Column 1st section (closer to joint)													
		Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
				n-set	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
H-1	1	whole	76.2	1	12.7	460.57	0	0	0	0	0	0	0	0	0
H-2	1	whole	76.2	1	12.7	461.95	0	0	0	0	0	0	0	0	0
MJ-1	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-2	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-3	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-4	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-5	5	577.85	88.9	2	9.53	484.70	0	0	0	0	0	0	0	0	0
MJ-6	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-7	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-8	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-9	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-10	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-11	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-12	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-13	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-14	5	577.85	88.9	2	12.7	408.86	0	0	0	0	0	0	0	0	0
FI-1	9	500	100	1	6.5	240.00	2	6.5	240.00	0	0	0.00	0	0	0
FI-2	2	300	60	1	6.5	240.00	4	6.5	240.00	4	6.5	240.00	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (11/51)

No. ID	Transverse Reinforcement - 1														
	Type of Hz. Reinf.	Column 1st section (closer to joint)													
		Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
				n-set	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
B-1	2	whole	75	1	12.7	427.00	2	12.7	345.00	2	12.7	345.00	0	0	0
B-2	2	whole	75	1	6.4	427.00	2	6.5	398.00	2	6.5	398.00	0	0	0
Ve-1	2	whole	40.64	1	6.35	448.16	2	6.35	448.16	2	6.35	448.16	0	0	0
Ve-2	2	whole	40.64	1	6.35	448.16	2	6.35	448.16	2	6.35	448.16	0	0	0
Bck-1	2	790	63	1	12.7	336.20	2	12.7	336.20	2	12.7	336.20	0	0	0
Bck-2	2	790	63	1	12.7	336.20	2	12.7	336.20	2	12.7	336.20	0	0	0
Bck-3	2	790	63	1	12.7	336.20	2	12.7	336.20	2	12.7	336.20	0	0	0
Pe-1	3	whole	178	1	10	283.00	0	0	0.00	1	10	283.00	0	0	0
R-1	3	whole	101.6	1	12.7	440.58	1	12.7	440.58	1	12.7	440.58	0	0	0
R-2	3	whole	101.6	1	12.7	467.47	1	12.7	467.47	1	12.7	467.47	0	0	0
R-3	3	whole	101.6	1	12.7	467.47	1	12.7	467.47	1	12.7	467.47	0	0	0
PM-1	3	360	60	1	10	321.00	0	0	0.00	1	10	321.00	0	0	0
PM-2	3	360	60	1	10	321.00	0	0	0.00	1	10	321.00	0	0	0
DW5-1	6	whole	88.9	1	12.7	351.63	0	0	0.00	0	0	0.00	1	12.7	351.63
DW5-2	6	whole	88.9	1	12.7	351.63	0	0	0.00	0	0	0.00	1	12.7	351.63
DW5-3	6	whole	88.9	1	12.7	351.63	0	0	0.00	0	0	0.00	1	12.7	351.63
A-1	1	whole	40.64	1	9.53	470.00	0	0	0.00	0	0	0.00	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (12/51)

No. ID	Transverse Reinforcement - 1														
	Type of Hz. Reinf.	Column 1^{st} section (closer to joint)													
		Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
				n-set	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
DW7-1	6	whole	88.9	1	12.7	351.63	0	0	0	0	0	0	1	12.7	351.63
DW7-2	6	whole	88.9	1	12.7	351.63	0	0	0	0	0	0	1	12.7	351.63
DW7-3	6	whole	88.9	1	12.7	351.63	0	0	0	0	0	0	1	12.7	351.63
Ge-1	1	whole	50	1	6	1058.40	0	0	0.00	0	0	0.00	0	0	0
Ge-2	1	whole	50	1	6	1058.40	0	0	0.00	0	0	0.00	0	0	0
Ge-3	1	whole	50	1	6	1058.40	0	0	0.00	0	0	0.00	0	0	0
Ge-4	1	whole	50	1	6	1058.40	0	0	0.00	0	0	0.00	0	0	0
L-1	1	whole	50	1	6.35	414.00	0	0	0.00	0	0	0.00	0	0	0
L-2	1	whole	50	1	6.35	414.00	0	0	0.00	0	0	0.00	0	0	0
FA-1	5	whole		2	6	291.06	0	0	0.00	0	0	0.00	0	0	0
FA-2	5	whole		2	6	291.06	0	0	0.00	0	0	0.00	0	0	0
FA-3	5	whole		2	6	291.06	0	0	0.00	0	0	0.00	0	0	0
FA-4	5	whole		4	6	291.06	0	0	0.00	0	0	0.00	0	0	0
Ae-1	3	whole	160	1	6	250.00	1	6	250.00	1	6	250.00	0	0	0
Ae-2	3	whole	160	1	6	250.00	1	6	250.00	1	6	250.00	0	0	0
Ae-3	3	whole	160	1	6	250.00	1	6	250.00	1	6	250.00	0	0	0
Ae-4	3	whole	160	1	6	250.00	1	6	250.00	1	6	250.00	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (13/51)

No.ID	Transverse Reinforcement -2													
	Column 2nd section (closer to column end)													
	Length	s_{vert}	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
	[mm]	[mm]	n-set	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
H-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-1	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-2	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-3	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-4	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-5	0	177.8	2	9.53	484.70	0	0	0	0	0	0	0	0	0
MJ-6	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-7	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-8	1124	177.8	2	9.53	408.86	0	0	0	0	0	0	0	0	0
MJ-9	1124	177.8	2	9.53	408.86	0	0	0	0	0	0	0	0	0
MJ-10	1124	177.8	2	9.53	408.86	0	0	0	0	0	0	0	0	0
MJ-11	1124	177.8	2	9.53	408.86	0	0	0	0	0	0	0	0	0
MJ-12	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-13	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
MJ-14	1124	177.8	2	12.7	408.86	0	0	0	0	0	0	0	0	0
FI-1	1330	100	1	6.5	240.00	2	6.5	240	0	0	0	0	0	0
FI-2	1530	60	1	6.5	240.00	4	6.5	240	4	6.5	240.00	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (14/51)

No.ID	Transverse Reinforcement -2													
	Column 2nd section (closer to column end)													
	Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
			n-set	d_{bar} [mm]	f_y [MPa]	n	d_{bar}	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
B-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ve-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ve-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-1	887	100	1	12.7	336.20	2	12.7	336.20	0	0	0	0	0	0
Bck-2	887	100	1	12.7	336.20	2	12.7	336.20	0	0	0	0	0	0
Bck-3	887	100	1	12.7	336.20	2	12.7	336.20	0	0	0	0	0	0
Pe-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PM-1	1315	60	1	10	321.00	0	0	0	1	10	321.00	0	0	0
PM-2	1315	60	1	10	321.00	0	0	0	1	10	321.00	0	0	0
DW5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (15/51)

No.ID	Transverse Reinforcement -2													
	Column 2nd section (closer to column end)													
	Length	s_{vert}	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
	[mm]	[mm]	n-set	d_{bar} [mm]	f_y [MPa]	n	d_{bar}	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
DW7-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW7-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW7-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (16/51)

No. ID	ecc. [mm]	Beam Dimension							
		Left Beam		Right Beam		b_b[mm]	h_b[mm]	cover-x[mm]	cover-y[mm]
		f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
H-1	0	37.92	3239	37.92	3239	304.80	508.00	38.1	38.1
H-2	0	20.20	3239	20.20	3239	304.80	508.00	38.1	38.1
MJ-1	0	26.20	2438	26.20	2438	279.4	457.2	66.9	66.9
MJ-2	0	41.78	2438	41.78	2438	279.4	457.2	66.9	66.9
MJ-3	0	26.61	2438	26.61	2438	279.4	457.2	66.9	66.9
MJ-4	0	36.06	2438	36.06	2438	406.4	457.2	66.9	66.9
MJ-5	0	35.85	2438	35.85	2438	279.4	457.2	66.9	66.9
MJ-6	0	36.75	2438	36.75	2438	279.4	457.2	66.9	66.9
MJ-7	0	37.23	2438	37.23	2438	406.4	457.2	66.9	66.9
MJ-8	0	33.10	2438	33.10	2438	279.40	457.20	66.9	66.9
MJ-9	0	31.03	2438	31.03	2438	279.40	457.20	66.9	66.9
MJ-10	0	29.58	2438	29.58	2438	279.40	457.20	66.9	66.9
MJ-11	0	25.65	2438	25.65	2438	406.40	457.20	66.9	66.9
MJ-12	0	35.16	2438	35.16	2438	279.4	457.2	66.9	66.9
MJ-13	0	41.30	2438	41.30	2438	279.4	457.2	66.9	66.9
MJ-14	0	33.16	2438	33.16	2438	406.4	457.2	66.9	66.9
FI-1	0	42.90	1425	42.90	1425	200	300	30	30
FI-2	0	39.30	1425	39.30	1425	200	300	30	30

Table A2 — Database storage for concentric-interior beam-column joints (17/51)

No. ID	ecc. [mm]	Beam Dimension							
		Left Beam		Right Beam		b_b[mm]	h_b[mm]	cover-x[mm]	cover-y[mm]
		f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
B-1	0	27.90	2439	27.90	2439	356	610	41	41
B-2	0	31.50	2439	31.50	2439	356	610	41	41
Ve-1	0	31.10	1829	31.10	1829	228.6	406.4	19.05	19.05
Ve-2	0	31.51	1829	31.51	1829	228.6	406.4	19.05	19.05
Bck-1	0	34.70	2438	34.70	2438	356	610	41	41
Bck-2	0	34.20	2438	34.20	2438	356	610	41	41
Bck-3	0	28.90	2438	28.90	2438	356	610	41	41
Pe-1	0	34.00	2870	34.00	2870	229	457	38	38
R-1	0	36.82	3239	36.82	3239	304.8	660.4	65.42	65.42
R-2	0	35.58	3239	35.58	3239	304.8	660.4	65.42	65.42
R-3	0	32.47	3239	32.47	3239	304.8	660.4	65.42	65.42
PM-1	0	41.30	2870	41.30	2870	229	457	38	38
PM-2	0	46.90	2870	46.90	2870	229	457	38	38
DW5-1	0	34.34	1067	34.34	1067	279.4	419.1	50.8	50.8
DW5-2	0	33.65	1067	33.65	1067	279.4	419.1	50.8	50.8
DW5-3	0	31.03	1067	31.03	1067	279.4	419.1	50.8	50.8
A-1	0	31.10	1370	31.10	1370	343	343	43	43

Table A2 — Database storage for concentric-interior beam-column joints (18/51)

No. ID	ecc. [mm]	Beam Dimension							
		Left Beam		Right Beam		b_b[mm]	h_b[mm]	cover-x[mm]	cover-y[mm]
		f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
DW7-1	0	41.58	1248	41.58	1248	279.40	419.10	50.8	50.8
DW7-2	0	30.75	1248	30.75	1248	279.40	419.10	50.8	50.8
DW7-3	0	28.27	1248	28.27	1248	279.40	419.10	50.8	50.8
Ge-1	0	25.87	1500	25.87	1500	200	350	30	30
Ge-2	0	27.44	1500	27.44	1500	200	350	30	30
Ge-3	0	28.13	1500	28.13	1500	200	350	30	30
Ge-4	0	26.85	1500	26.85	1500	200	350	30	30
L-1	0	27.40	1016	27.40	1016	203.2	304.8	25	25
L-2	0	27.20	1016	27.20	1016	203.2	304.8	25	25
FA-1	0	40.18	1000	40.18	1000	160	250	25	25
FA-2	0	40.18	1000	40.18	1000	160	250	25	25
FA-3	0	40.18	1000	40.18	1000	160	250	25	25
FA-4	0	40.18	1000	40.18	1000	160	250	25	25
Ae-1	0	43.10	1650	43.10	1650	250	300	44	44
Ae-2	0	46.10	1650	46.10	1650	250	300	44	44
Ae-3	0	50.60	1650	50.60	1650	250	300	44	44
Ae-4	0	45.10	1650	45.10	1650	250	300	44	44

Table A2 — Database storage for concentric-interior beam-column joints (19/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-1																				
	1st layer										2nd layer							3rd layer			
	d_1	Corner bar			Intermediate Bar			Inner Bar			d_2	Outer bar			Inner Bar			d_3	Outer + Inner Bar		
	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	[mm]	n	d_{bar} [mm]	f_y $[MPa]$
H-1	469.9	2	25.4	435.06	2	25.4	435.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H-2	469.9	2	25.4	448.16	2	25.4	448.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-1	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-2	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-3	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-4	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-5	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-6	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-7	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-8	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-9	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-10	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-11	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-12	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-13	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-14	390.3	2	32.2	448.85	1	32.2	448.85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI-1	270	2	20	280.00	1	20	280.00	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0
FI-2	270	2	12	318.00	1	12	318.00	0	0	0	240	2	12	318.00	1	12	318	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (20/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-1																				
	1st layer										2nd layer							3rd layer			
	d_1	Corner bar			Intermediate Bar			Inner Bar			d_2	Outer bar			Inner Bar			d_3	Outer + Inner Bar		
	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	[mm]	n	d_{bar} [mm]	f_y $[MPa]$
B-1	569	2	20	288.10	2	20	288.10	0	0	0	531	2	20	288.10	2	20	288.1	0	0	0	0
B-2	569	2	20	288.10	2	20	288.10	0	0	0	531	2	20	288.10	2	20	288.1	0	0	0	0
Ve-1	387.35	2	19.1	489.53	2	19.1	489.53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ve-2	387.35	2	19.1	489.53	2	19.1	489.53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-1	569	2	19	297.60	2	19	297.60	0	0	0	531	2	19	297.60	2	19	297.6	0	0	0	0
Bck-2	569	2	19	297.60	2	19	297.60	0	0	0	531	2	19	297.60	0	0	0	0	0	0	0
Bck-3	569	2	19	297.60	2	19	297.60	0	0	0	531	2	19	297.60	0	0	0	0	0	0	0
Pe-1	419	2	16	338.00	2	16	338.00	0	0	0	383	2	16	338.00	2	16	338	0	0	0	0
R-1	594.98	2	35.8	464.71	0	0	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-2	594.98	2	35.8	464.71	0	0	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-3	594.98	2	35.8	464.71	0	0	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PM-1	419	2	16	315.00	2	16	315.00	0	0	0	383	2	16	315.00	2	16	315	0	0	0	0
PM-2	419	2	20	307.00	2	20	307.00	0	0	0	383	2	20	307.00	0	0	0	0	0	0	0
DW5-1	368.3	2	19.1	330.95	2	19.1	330.95	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0
DW5-2	368.3	2	19.1	330.95	2	19.1	330.95	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0
DW5-3	368.3	2	19.1	330.95	1	19.1	330.95	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0
A-1	286	2	19.1	470.00	1	19.1	470.00	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (21/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-1																				
	1st layer										2nd layer							3rd layer			
	d_1 [mm]	Corner bar			Intermediate Bar			Inner Bar			d_2 [mm]	Outer bar			Inner Bar			d_3 [mm]	Outer + Inner Bar		
		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$
DW7-1	342.9	2	22.2	330.95	2	12.7	351.63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW7-2	342.9	2	22.2	330.95	2	12.7	351.63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW7-3	342.9	2	22.2	330.95	0	0	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-1	320	2	13	377.30	1	13	377.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-2	320	2	13	377.30	1	13	377.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-3	320	2	13	377.30	1	13	377.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-4	320	2	13	377.30	1	13	377.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-1	279.8	2	9.53	448.00	2	9.53	448.00	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0
L-2	279.8	2	9.53	448.00	2	9.53	448.00	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0
FA-1	225	2	10	1068.20	2	10	1068.20	0	0	0	200	2	10	1068.20	2	10	1068.2	0	0	0	0
FA-2	225	2	10	408.66	2	10	408.66	0	0	0	200	2	10	408.66	2	10	408.66	0	0	0	0
FA-3	225	2	10	1068.20	2	10	1068.20	0	0	0	200	2	10	1068.20	2	10	1068.2	0	0	0	0
FA-4	225	2	10	1068.20	2	10	1068.20	0	0	0	200	2	10	1068.20	2	10	1068.2	0	0	0	0
Ae-1	256	2	16	513.30	2	16	513.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-2	256	2	16	558.40	2	16	558.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-3	256	2	16	594.70	2	16	594.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-4	256	2	16	518.00	2	16	518.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (22/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-2														
	4th layer				5th layer				6th layer						
	d_4 [mm]	Outer+Inner bar			d_5 [mm]	Outer+Inner bar			d_6 [mm]	Outer Bars			Inner Bar		
		n	d_{bar} [mm]	$f_y[MPa]$		n	d_{bar} [mm]	$f_y[MPa]$		n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$
H-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI-2	0	0	0	0	0	0	0	0	60	2	12	318	1	12	318

Table A2 — Database storage for concentric-interior beam-column joints (23/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-2														
	4th layer				5th layer				6th layer						
	d_4	Outer+Inner bar			d_5	Outer+Inner bar			d_6	Outer Bars			Inner Bar		
	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$
B-1	0	0	0	0	0	0	0	0	79	2	20	288.1	2	20	288.1
B-2	0	0	0	0	0	0	0	0	79	2	20	288.1	2	20	288.1
Ve-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ve-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-1	0	0	0	0	0	0	0	0	79	2	19	297.6	2	19	297.6
Bck-2	0	0	0	0	0	0	0	0	79	2	19	297.6	0	0	0
Bck-3	0	0	0	0	0	0	0	0	79	2	19	297.6	0	0	0
Pe-1	0	0	0	0	0	0	0	0	74	2	16	338	2	16	338
R-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PM-1	0	0	0	0	0	0	0	0	74	2	16	315	2	16	315
PM-2	0	0	0	0	0	0	0	0	74	2	20	307	0	0	0
DW5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (24/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-2														
	4th layer				5th layer				6th layer						
	d_4 [mm]	Outer+Inner bar			d_5 [mm]	Outer+Inner bar			d_6 [mm]	Outer Bars			Inner Bar		
		n	d_{bar} [mm]	$f_y[MPa]$		n	d_{bar} [mm]	$f_y[MPa]$		n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$
DW7-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW7-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW7-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-1	0	0	0	0	0	0	0	0	50	2	10	1068.2	2	10	1068.2
FA-2	0	0	0	0	0	0	0	0	50	2	10	408.66	2	10	408.66
FA-3	0	0	0	0	0	0	0	0	50	2	10	1068.2	2	10	1068.2
FA-4	0	0	0	0	0	0	0	0	50	2	10	1068.2	2	10	1068.2
Ae-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (25/51)

No. ID	Beam Longitudinal Reinforcement-3									
	7th layer									
	d_7 [mm]	Corner bar			Intermediate Bar			Inner Bar		
		n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$
H-1	38.1	2	25.4	435.06	0	0	0.00	0	0	0
H-2	38.1	2	25.4	448.16	0	0	0.00	0	0	0
MJ-1	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-2	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-3	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-4	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-5	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-6	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-7	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-8	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-9	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-10	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-11	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-12	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-13	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
MJ-14	66.9	2	25.4	448.85	1	25.4	448.85	0	0	0
FI-1	30	2	20	280.00	1	20	280.00	0	0	0
FI-2	30	2	12	318.00	1	12	318.00	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (26/51)

No. ID	Beam Longitudinal Reinforcement-3									
	7th layer									
	d_7 [mm]	Corner bar			Intermediate Bar			Inner Bar		
		n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$
B-1	41	2	20	288.10	2	20	288.10	0	0	0
B-2	41	2	20	288.10	2	20	288.10	0	0	0
Ve-1	19.05	2	15.9	489.53	1	15.9	489.53	0	0	0
Ve-2	19.05	2	15.9	489.53	1	15.9	489.53	0	0	0
Bck-1	41	2	19	297.60	2	19	297.60	0	0	0
Bck-2	41	2	19	297.60	2	19	297.60	0	0	0
Bck-3	41	2	19	297.60	2	19	297.60	0	0	0
Pe-1	38	2	16	338.00	2	16	338.00	0	0	0
R-1	65.42	2	35.8	464.71	0	0	0.00	0	0	0
R-2	65.42	2	35.8	464.71	0	0	0.00	0	0	0
R-3	65.42	2	35.8	464.71	0	0	0.00	0	0	0
PM-1	38	2	16	315.00	2	16	315.00	0	0	0
PM-2	38	2	20	307.00	2	20	305.00	0	0	0
DW5-1	55.4	2	22.2	344.74	2	22.2	344.74	0	0	0
DW5-2	55.4	2	22.2	344.74	2	22.2	344.74	0	0	0
DW5-3	55.4	2	22.2	344.74	1	22.2	344.74	0	0	0
A-1	43	2	19.1	470.00	2	19.1	470.00	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (27/51)

No. ID	Beam Longitudinal Reinforcement-3									
	7th layer									
	d_7 [mm]	Corner bar			Intermediate Bar			Inner Bar		
		n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$
DW7-1	76.2	2	19.1	344.74	2	19.1	344.74	0	0	0
DW7-2	76.2	2	19.1	344.74	2	19.1	344.74	0	0	0
DW7-3	76.2	2	19.1	344.74	1	19.1	344.74	0	0	0
Ge-1	30	2	13	377.30	1	13	377.30	0	0	0
Ge-2	30	2	13	377.30	1	13	377.30	0	0	0
Ge-3	30	2	13	377.30	1	13	377.30	0	0	0
Ge-4	30	2	13	377.30	1	13	377.30	0	0	0
L-1	25	2	9.53	448.00	2	9.53	448.00	0	0	0
L-2	25	2	9.53	448.00	2	9.53	448.00	0	0	0
FA-1	25	2	10	1068.20	2	10	1068.20	0	0	0
FA-2	25	2	10	408.66	2	10	408.66	0	0	0
FA-3	25	2	10	1068.20	2	10	1068.20	0	0	0
FA-4	25	2	10	1068.20	2	10	1068.20	0	0	0
Ae-1	44	2	16	513.30	2	16	513.30	0	0	0
Ae-2	44	2	16	558.40	2	16	558.40	0	0	0
Ae-3	44	2	16	594.70	2	16	594.70	0	0	0
Ae-4	44	2	16	518.00	2	16	518.00	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (28/51)

No. ID	Beam Transverse Reinf.													
	Section-1							Section-2						
	Length [mm]	s_{hz_1} [mm]	f_y [MPa]	Stirrup		Vert. Ties		Length [mm]	s_{hz_2} [mm]	f_y [MPa]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
H-1	whole beam	114.3	461.95	2	9.53	0	0	0	0	0	0	0	0	0
H-2	whole beam	114.3	461.95	2	9.53	0	0	0	0	0	0	0	0	0
MJ-1	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-2	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-3	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-4	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-5	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-6	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-7	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-8	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-9	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-10	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-11	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-12	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-13	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
MJ-14	1625.6	88.9	484.70	2	9.53	0	0	812.8	177.8	484.70	0	9.53	0	0
FI-1	500	100	240.00	2	6.5	1	6.5	925	150	240.00	2	6.5	1	6.5
FI-2	500	60	240.00	2	6.5	3	6.5	925	100	240.00	2	6.5	3	6.5

Table A2 — Database storage for concentric-interior beam-column joints (29/51)

No. ID	Beam Transverse Reinf.													
	Section-1							Section-2						
	Length [mm]	s_{hz_1} [mm]	f_y [MPa]	Stirrup		Vert. Ties		Length [mm]	s_{hz_2} [mm]	f_y [MPa]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
B-1	650	75	398.00	2	6.5	2	6.5	1789	200	398.00	2	6.5	2	6.5
B-2	650	75	398.00	2	6.5	2	6.5	1789	200	398.00	2	6.5	2	6.5
Ve-1	whole beam	88.9	448.16	2	6.35	0	0	0	0	0	0	0	0	0
Ve-2	whole beam	88.9	448.16	2	6.35	0	0	0	0	0	0	0	0	0
Bck-1	975	51	329.20	2	6.3	2	6.3	1463	203	329.20	2	6.3	2	6.3
Bck-2	975	51	329.20	2	6.3	2	6.3	1463	203	329.20	2	6.3	2	6.3
Bck-3	975	51	329.20	2	6.3	2	6.3	1463	203	329.20	2	6.3	2	6.3
Pe-1	914	89	283.00	2	10	0	0	1956	89	283.00	2	10	0	0
R-1	whole beam	127	481.95	2	9.53	0	0	0	0	0.00	2	0	0	0
R-2	whole beam	127	481.95	2	9.53	0	0	0	0	0.00	2	0	0	0
R-3	whole beam	127	481.95	2	9.53	0	0	0	0	0.00	2	0	0	0
PM-1	890	89	321.00	2	10	2	10	1980	89	321.00	2	10	2	10
PM-2	890	89	321.00	2	10	2	10	1980	89	321.00	2	10	2	10
DW5-1	whole beam	88.9	336.47	2	9.53	0	0	0	0	0	0	0	0	0
DW5-2	whole beam	88.9	336.47	2	9.53	0	0	0	0	0	0	0	0	0
DW5-3	whole beam	88.9	336.47	2	9.53	0	0	0	0	0	0	0	0	0
A-1	whole beam	102	470.00		9.53	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (30/51)

No. ID	Beam Transverse Reinf.													
	Section-1							Section-2						
	Length [mm]	s_{hz_1} [mm]	f_y [MPa]	Stirrup		Vert. Ties		Length [mm]	s_{hz_2} [mm]	f_y [MPa]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
DW7-1	whole beam	88.9	351.63	2	9.53	0	0	0	0	0	0	0	0	0
DW7-2	whole beam	88.9	351.63	2	9.53	0	0	0	0	0	0	0	0	0
DW7-3	whole beam	88.9	351.63	2	9.53	0	0	0	0	0	0	0	0	0
Ge-1	500	50	372.40	2	6	1	6	1000	100	372.40	0	6	0	0
Ge-2	500	100	372.40	2	6	0	0	1000	100	372.40	0	6	0	0
Ge-3	500	50	372.40	2	6	1	6	1000	100	372.40	0	6	0	0
Ge-4	500	50	372.40	2	6	1	6	1000	100	372.40	0	6	0	0
L-1	whole beam	50	414.00	2	6.35	0	0	0	0	0	0	0	0	0
L-2	whole beam	50	414.00	2	6.35	0	0	0	0	0	0	0	0	0
FA-1	whole beam	?	291.06	2	6	0	0	0	0	0	0	0	0	0
FA-2	whole beam	?	291.06	2	6	0	0	0	0	0	0	0	0	0
FA-3	whole beam	?	291.06	2	6	0	0	0	0	0	0	0	0	0
FA-4	whole beam	?	291.06	2	6	0	0	0	0	0	0	0	0	0
Ae-1	whole beam	130	250.00	2	6	0	0	0	0	0	0	0	0	0
Ae-2	whole beam	130	250.00	2	6	0	0	0	0	0	0	0	0	0
Ae-3	whole beam	130	250.00	2	6	0	0	0	0	0	0	0	0	0
Ae-4	whole beam	130	250.00	2	6	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (31/51)

No. ID	Joint Dimension				Joint Transverse Reinforcement - 1								
	b_{jt}[mm]	h_{jt}[mm]	d_{jt}[mm]	f_c'[MPa]	Type of Hz. Reinf.	No. of joint set	$s_{vert.}$	Outer hoop			Ties in X-dir		
								n-set	d_{bar}	f_y[MPa]	n-set	d_{bar}	f_y[MPa]
H-1	381	381	431.8	37.92	1	6	76.2	1	12.7	460.57	0	0	0
H-2	381	381	431.8	20.20	1	5	76.2	1	12.7	461.95	0	0	0
MJ-1	330.2	457.2	323.4	26.20	1	2	152.4	1	12.7	408.86	0	0	0
MJ-2	330.2	457.2	323.4	41.78	1	2	152.4	1	12.7	408.86	0	0	0
MJ-3	330.2	457.2	323.4	26.61	1	2	152.4	1	12.7	408.86	0	0	0
MJ-4	457.2	330.2	323.4	36.06	1	2	152.4	1	12.7	408.86	0	0	0
MJ-5	330.2	457.2	323.4	35.85	1	2	152.4	1	12.7	408.86	0	0	0
MJ-6	330.2	457.2	323.4	36.75	1	2	152.4	1	12.7	408.86	0	0	0
MJ-7	457.2	330.2	323.4	37.23	1	2	152.4	1	12.7	408.86	0	0	0
MJ-8	330.2	457.2	323.4	33.10	1	2	152.4	1	12.7	408.86	0	0	0
MJ-9	330.2	457.2	323.4	31.03	1	2	152.4	1	12.7	408.86	0	0	0
MJ-10	330.2	457.2	323.4	29.58	1	2	152.4	1	12.7	408.86	0	0	0
MJ-11	457.2	330.2	323.4	25.65	1	2	152.4	1	12.7	408.86	0	0	0
MJ-12	330.2	457.2	323.4	35.16	1	6	50.8	1	15.9	422.65	0	0	0
MJ-13	330.2	457.2	323.4	41.30	1	6	50.8	1	12.7	408.86	0	0	0
MJ-14	457.2	330.2	323.4	33.16	1	6	50.8	1	12.7	408.86	0	0	0
FI-1	250	300	240	42.90	4	5	40	1	12	240.00	2	10	240.00
FI-2	250	300	240	39.30	2	5	40	1	12	240.00	2	10	240.00

Table A2 — Database storage for concentric-interior beam-column joints (32/51)

No. ID	Joint Dimension				Joint Transverse Reinforcement - 1								
	b_{jt}[mm]	h_{jt}[mm]	d_{jt}[mm]	f_c'[MPa]	Type of Hz. Reinf.	No. of joint set	$s_{vert.}$	Outer hoop			Ties in X-dir		
								n-set	d_{bar}	f_y[MPa]	n-set	d_{bar}	f_y[MPa]
B-1	457	457	528	27.90		4	120	1	12.7	427.00	2	12.7	345.00
B-2	457	457	528	31.50		4	126	1	6.4	398.00	2	6.5	398.00
Ve-1	431.8	431.8	368.3	31.10	2	6	40.64	1	6.35	448.16	2	6.35	448.16
Ve-2	431.8	431.8	368.3	31.51	2	6	40.64	1	6.35	448.16	2	6.35	448.16
Bck-1	457	457	528	34.70	2	8	63	1	12.7	336.20	4	12.7	336.20
Bck-2	457	457	528	34.20	2	8	63	1	12.7	336.20	4	12.7	336.20
Bck-3	457	457	528	28.90	2	6	76	1	12.7	336.20	4	12.7	336.20
Pe-1	305	406	381	34.00	3	5	86	1	16	305.00	0	0	0
R-1	381	381	529.56	36.82	3	11	101.6	1	12.7	440.58	0	0	0
R-2	381	381	529.56	35.58	3	11	101.6	1	12.7	467.47	0	0	0
R-3	381	381	529.56	32.47	3	11	101.6	1	12.7	467.47	0	0	0
PM-1	305	406	381	41.30	3	8	52	1	16	320.00	0	0	0
PM-2	305	406	381	46.90	3	6	52	1	12	320.00	0	0	0
DW5-1	361.95	361.95	317.5	34.34	6	2	152.4	1	12.7	351.63	0	0	0
DW5-2	361.95	361.95	317.5	33.65	6	3	101.6	1	12.7	351.63	0	0	0
DW5-3	361.95	361.95	317.5	31.03	6	2	152.4	1	12.7	351.63	0	0	0
A-1	343	457	257	31.10	1	3	85	1	9.53	470.00	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (33/51)

No. ID	Joint Dimension				Joint Transverse Reinforcement - 1								
	b_{jt}[mm]	h_{jt}[mm]	d_{jt}[mm]	f_c'[MPa]	Type of Hz. Reinf.	No. of joint set	$s_{vert.}$	Outer hoop			Ties in X-dir		
								n-set	d_{bar}	f_y[MPa]	n-set	d_{bar}	f_y[MPa]
DW7-1	361.95	361.95	317.5	41.58	6	2	152.4	1	12.7	351.63	0	0	0
DW7-2	361.95	361.95	317.5	30.75	6	3	101.6	1	12.7	351.63	0	0	0
DW7-3	361.95	361.95	317.5	28.27	6	2	152.4	1	12.7	351.63	0	0	0
Ge-1	300	300	290	25.87	5	5	43	2	5	1058.40	0	0	0
Ge-2	300	300	290	27.44	5	5	43	2	5	1058.40	0	0	0
Ge-3	300	300	290	28.13	1	5	45	1	6	372.40	0	0	0
Ge-4	300	300	290	26.85	1	3	87.5	1	6	372.40	0	0	0
L-1	254	254	254.8	27.40	1	4	50	1	6.35	414.00	0	0	0
L-2	254	254	254.8	27.20	1	4	50	1	6.35	414.00	0	0	0
FA-1	220	220	200	40.18	1	3	62	1	6	291.00	0	0	0
FA-2	220	220	200	40.18	1	3	62	1	6	291.00	0	0	0
FA-3	220	220	200	40.18	1	3	62	1	6	291.00	0	0	0
FA-4	220	220	200	40.18	5	4	46	2	6	291.00	0	0	0
Ae-1	300	300	212	43.10	0	0	0	0	0	0.00	0	0	0
Ae-2	300	300	212	46.10	0	0	0	0	0	0.00	0	0	0
Ae-3	300	300	212	50.60	3	3	75	1	12	594.70	1	12	594.70
Ae-4	300	300	212	45.10	3	3	75	1	12	518.00	1	12	518.00

Table A2 — Database storage for concentric-interior beam-column joints (34/51)

No. ID	Joint Transverse Reinforcement -2						Provided Reinf		Code req		$\frac{A_{sh\_prov}}{A_{sh\_req}}$
	Ties in Y Direction			Diagonal Ties			Ash-x [%]	Ash-y [%]	Ash-x [%]	Ash-y [%]	
	n-set	d_{bar} [mm]	f_y[MPa]	n-set	d_{bar}[mm]	f_y[MPa]					
H-1	0	0	0	0	0	0	0.010	0.010	0.008	0.008	1.23
H-2	0	0	0	0	0	0	0.010	0.010	0.004	0.004	2.32
MJ-1	0	0	0	0	0	0	0.00681	0.00448	0.01284	0.01284	0.53
MJ-2	0	0	0	0	0	0	0.00654	0.00436	0.01717	0.01717	0.38
MJ-3	0	0	0	0	0	0	0.00645	0.00432	0.01023	0.01023	0.63
MJ-4	0	0	0	0	0	0	0.00393	0.00563	0.00794	0.00794	0.50
MJ-5	0	0	0	0	0	0	0.00645	0.00432	0.01378	0.01378	0.47
MJ-6	0	0	0	0	0	0	0.00645	0.00432	0.01412	0.01412	0.46
MJ-7	0	0	0	0	0	0	0.00440	0.00663	0.01629	0.01629	0.27
MJ-8	0	0	0	0	0	0	0.006	0.004	0.013	0.013	0.51
MJ-9	0	0	0	0	0	0	0.006	0.004	0.012	0.012	0.54
MJ-10	0	0	0	0	0	0	0.006	0.004	0.011	0.011	0.57
MJ-11	0	0	0	0	0	0	0.004	0.007	0.011	0.011	0.39
MJ-12	0	0	0	0	0	0	0.02960	0.01998	0.01154	0.01154	2.56
MJ-13	0	0	0	0	0	0	0.01935	0.01296	0.01587	0.01587	1.22
MJ-14	0	0	0	0	0	0	0.01320	0.01990	0.01451	0.01451	0.91
FI-1	1	6.5	240.00	0	0	0	0.04093	0.02282	0.01609	0.01609	2.54
FI-2	2	6.5	240.00	0	0	0	0.04238	0.02649	0.01474	0.01474	2.88

Table A2 — Database storage for concentric-interior beam-column joints (35/51)

No. ID	Joint Transverse Reinforcement -2						Provided Reinf		Code req		$\frac{A_{sh\_prov}}{A_{sh\_req}}$
	Ties in Y Direction			Diagonal Ties			Ash-x [%]	Ash-y [%]	Ash-x [%]	Ash-y [%]	
	n-set	d_{bar} [mm]	f_y[MPa]	n-set	d_{bar}[mm]	f_y[MPa]					
B-1	2	12.7	345.00	0	0	0	0.01004	0.01004	0.00588	0.00588	1.71
B-2	2	6.5	398.00	0	0	0	0.00254	0.00254	0.00712	0.00712	0.36
Ve-1	2	6.35	448.16	0	0	0	0.00732	0.00732	0.00624	0.00624	1.17
Ve-2	2	6.35	448.16	0	0	0	0.00732	0.00732	0.00633	0.00633	1.16
Bck-1	4	12.7	336.20	0	0	0	0.02881	0.02881	0.00929	0.00929	3.10
Bck-2	4	12.7	336.20	0	0	0	0.02881	0.02881	0.00916	0.00916	3.15
Bck-3	4	12.7	336.20	0	0	0	0.02388	0.02388	0.00774	0.00774	3.09
Pe-1	1	16	305.00	0	0	0	0.02077	0.02150	0.02302	0.02302	0.90
R-1	1	12.7	440.58	0	0	0	0.00801	0.01201	0.01247	0.01247	0.64
R-2	1	12.7	467.47	0	0	0	0.00809	0.01213	0.01205	0.01205	0.67
R-3	1	12.7	467.47	0	0	0	0.00801	0.01201	0.01037	0.01037	0.77
PM-1	1	16	320.00	0	0	0	0.02568	0.02884	0.01162	0.01162	2.21
PM-2	1	16	320.00	0	0	0	0.01484	0.02084	0.01319	0.01319	1.12
DW5-1	1	12.7	351.63	0	0	0	0.00912	0.00912	0.01035	0.01035	0.88
DW5-2	1	12.7	351.63	0	0	0	0.01367	0.01367	0.01014	0.01014	1.35
DW5-3	1	12.7	351.63	0	0	0	0.00921	0.00921	0.01010	0.01010	0.91
A-1	0	0	0	0	0	0	0.00575	0.00413	0.00640	0.00640	0.90

Table A2 — Database storage for concentric-interior beam-column joints (36/51)

No. ID	Joint Transverse Reinforcement -2						Provided Reinf		Code req		$\frac{A_{sh\_prov}}{A_{sh\_req}}$
	Ties in Y Direction			Diagonal Ties			Ash-x [%]	Ash-y [%]	Ash-x [%]	Ash-y [%]	
	n-set	d_{bar} [mm]	f_y[MPa]	n-set	d_{bar}[mm]	f_y[MPa]					
DW7-1	0	0	0	1	12.7	351.63	0.009	0.009	0.012	0.012	0.75
DW7-2	0	0	0	1	12.7	351.63	0.014	0.014	0.009	0.009	1.53
DW7-3	0	0	0	1	12.7	351.63	0.009	0.009	0.009	0.009	1.03
Ge-1	0	0	0	0	0	0	0.00694	0.00694	0.00221	0.00221	3.14
Ge-2	0	0	0	0	0	0	0.00694	0.00694	0.00234	0.00234	2.96
Ge-3	0	0	0	0	0	0	0.00474	0.00474	0.00680	0.00680	0.70
Ge-4	0	0	0	0	0	0	0.00244	0.00244	0.00649	0.00649	0.38
L-1	0	0	0	0	0	0	0.00544	0.00544	0.00596	0.00596	0.91
L-2	0	0	0	0	0	0	0.00544	0.00544	0.00591	0.00591	0.92
FA-1	0	0	0	0	0	0	0.00493	0.00493	0.01716	0.01716	0.29
FA-2	0	0	0	0	0	0	0.00493	0.00493	0.01716	0.01716	0.29
FA-3	0	0	0	0	0	0	0.00493	0.00493	0.01716	0.01716	0.29
FA-4	0	0	0	0	0	0	0.01328	0.01328	0.01716	0.01716	0.77
Ae-1	0	0	0	0	0	0	0.00000	0.00000	0.00000	0.00000	0.00
Ae-2	0	0	0	0	0	0	0.00000	0.00000	0.00000	0.00000	0.00
Ae-3	1	12	594.7	0	0	0	0.01794	0.01794	0.01065	0.01065	1.68
Ae-4	1	12	518	0	0	0	0.01794	0.01794	0.01090	0.01090	1.65

Table A2 — Database storage for concentric-interior beam-column joints (37/51)

No. ID	TB horizontal relative position to main beam	TB vertical relative position to main beam	Transverse Beam Dimension							
			North Beam		South Beam		b_{tb}[mm]	h_{tb}[mm]	Cover-x[mm]	Cover-y[mm]
			f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
H-1	0	0	20.20	short	20.20	0	304.8	508	38.1	38.1
H-2	0	0	20.20	short	20.20	short	304.8	508	38.1	38.1
MJ-1	0	0	0	0	0	0	0	0	0	0
MJ-2	0	0	0	0	0	0	0	0	0	0
MJ-3	0	0	0	0	0	0	0	0	0	0
MJ-4	0	0	0	0	0	0	0	0	0	0
MJ-5	0	0	0	0	0	0	0	0	0	0
MJ-6	0	0	0	0	0	0	0	0	0	0
MJ-7	0	0	0	0	0	0	0	0	0	0
MJ-8	-101.6	76.2	33.10	609.6	33.10	609.6	381	381	66.9	66.9
MJ-9	0	76.2	31.03	609.6	31.03	609.6	203.2	381	66.9	66.9
MJ-10	0	76.2	29.58	609.6	29.58	609.6	203.2	381	66.9	66.9
MJ-11	0	76.2	25.65	609.6	25.65	609.6	152.4	381	66.9	66.9
MJ-12	0	0	0	0	0	0	0	0	0	0
MJ-13	0	0	0	0	0	0	0	0	0	0
MJ-14	0	0	0	0	0	0	0	0	0	0
FI-1	0	0	0	0	0	0	0	0	0	0
FI-2	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (38/51)

No. ID	TB horizontal relative position to main beam	TB vertical relative position to main beam	Transverse Beam Dimension							
			North Beam		South Beam					
			f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]	b_{tb}[mm]	h_{tb}[mm]	Cover-x[mm]	Cover-y[mm]
B-1	0	0	0	0	0	0	0	0	0	0
B-2	0	0	0	0	0	0	0	0	0	0
Ve-1	0	0	0	0	0	0	0	0	0	0
Ve-2	0	0	0	0	0	0	0	0	0	0
Bck-1	0	0	0	0	0	0	0	0	0	0
Bck-2	0	0	0	0	0	0	0	0	0	0
Bck-3	0	0	0	0	0	0	0	0	0	0
Pe-1	0	0	0	0	0	0	0	0	0	0
R-1	0	0	0	0	0	0	0	0	0	0
R-2	0	0	0	0	0	0	0	0	0	0
R-3	0	0	0	0	0	0	0	0	0	0
PM-1	0	0	0	0	0	0	0	0	0	0
PM-2	0	0	0	0	0	0	0	0	0	0
DW5-1	0	0	0	0	0	0	0	0	0	0
DW5-2	0	0	0	0	0	0	0	0	0	0
DW5-3	0	0	0	0	0	0	0	0	0	0
A-1	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (39/51)

No. ID	TB horizontal relative position to main beam	TB vertical relative position to main beam	Transverse Beam Dimension							
			North Beam		South Beam		b_{tb}[mm]	h_{tb}[mm]	Cover-x[mm]	Cover-y[mm]
			f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
DW7-1	0	0	41.58	367	41.58	367	279.4	381	76.2	76.2
DW7-2	0	0	30.75	367	30.75	367	279.4	381	76.2	76.2
DW7-3	0	0	28.27	367	28.27	367	279.4	381	76.2	76.2
Ge-1	0	0	0	0	0	0	0	0	0	0
Ge-2	0	0	0	0	0	0	0	0	0	0
Ge-3	0	0	0	0	0	0	0	0	0	0
Ge-4	0	0	0	0	0	0	0	0	0	0
L-1	0	0	0	0	0	0	0	0	0	0
L-2	0	0	0	0	0	0	0	0	0	0
FA-1	0	0	0	0	0	0	0	0	0	0
FA-2	0	0	0	0	0	0	0	0	0	0
FA-3	0	0	0	0	0	0	0	0	0	0
FA-4	0	0	0	0	0	0	0	0	0	0
Ae-1	0	0	0	0	0	0	0	0	0	0
Ae-2	0	0	0	0	0	0	0	0	0	0
Ae-3	0	0	0	0	0	0	0	0	0	0
Ae-4	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (40/51)

No. ID	Arrangement of Transverse Beam Longitudinal Reinforcement-1																	
	1st layer							2nd layer				3rd layer						
	d_1	Outer bar			Inner Bar			Side Bar				d_3	Outer Bar			Inner Bar		
	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar}	f_y $[MPa]$	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
H-1	469.9	2	25.4	448.16	2	25.4	448.16	0	0	0	0	38.1	2	25.4	448.16	0	0	0
H-2	469.9	2	25.4	448.16	2	25.4	448.16	0	0	0	0	38.1	2	25.4	448.16	0	0	0
MJ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-8	314.1	2	25.4	405.41	1	25.4	405.41	0	0	0	0	66.9	2	25.4	405.41	1	25.4	405.41
MJ-9	314.1	2	22.2	457.12	0	0	0.00	0	0	0	0	66.9	2	22.2	457.12	0	0	0.00
MJ-10	314.1	2	22.2	457.12	0	0	0.00	0	0	0	0	66.9	2	22.2	457.12	0	0	0.00
MJ-11	314.1	2	22.2	457.12	0	0	0.00	0	0	0	0	66.9	2	22.2	457.12	0	0	0.00
MJ-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (41/51)

No. ID	Arrangement of Transverse Beam Longitudinal Reinforcement-1																	
	1st layer							2nd layer				3rd layer						
	d_1 [mm]	Outer bar			Inner Bar			Side Bar				d_3 [mm]	Outer Bar			Inner Bar		
		n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	d_2 [mm]	n	d_{bar}	f_y [MPa]		n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
B-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ve-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ve-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pe-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PM-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PM-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (42/51)

No. ID	Arrangement of Transverse Beam Longitudinal Reinforcement-1																	
	1st layer							2nd layer				3rd layer						
	d_1 [mm]	Outer bar			Inner Bar			Side Bar				d_3 [mm]	Outer Bar			Inner Bar		
		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar}	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
DW7-1	304.8	2	19.1	344.74	2	19.1	344.74	0	0	0	0	76.2	2	19.1	344.74	2	19.1	344.74
DW7-2	304.8	2	19.1	344.74	2	19.1	344.74	0	0	0	0	76.2	2	19.1	344.74	2	19.1	344.74
DW7-3	304.8	2	19.1	344.74	1	19.1	344.74	0	0	0	0	76.2	2	19.1	344.74	1	19.1	344.74
Ge-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (43/51)

No. ID	Beam Transverse Reinf.						
	Whole Section						
	Length [mm]	f_y [MPa]	s_{hz}[mm]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
H-1	whole	461.95	114.3	2	9.53	0	0
H-2	whole	461.95	114.3	2	9.53	0	0
MJ-1	0	0	0	0	0	0	0
MJ-2	0	0	0	0	0	0	0
MJ-3	0	0	0	0	0	0	0
MJ-4	0	0	0	0	0	0	0
MJ-5	0	0	0	0	0	0	0
MJ-6	0	0	0	0	0	0	0
MJ-7	0	0	0	0	0	0	0
MJ-8	whole	484.70	50.8	2	9.53	0	0
MJ-9	whole	484.70	50.8	2	10.53	0	0
MJ-10	whole	484.70	50.8	2	11.53	0	0
MJ-11	whole	484.70	50.8	2	12.53	0	0
MJ-12	0	0	0	0	0	0	0
MJ-13	0	0	0	0	0	0	0
MJ-14	0	0	0	0	0	0	0
FI-1	0	0	0	0	0	0	0
FI-2	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (44/51)

No. ID	Beam Transverse Reinf.						
	Whole Section						
	Length [mm]	f_y [MPa]	s_{hz}[mm]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
B-1	0	0	0	0	0	0	0
B-2	0	0	0	0	0	0	0
Ve-1	0	0	0	0	0	0	0
Ve-2	0	0	0	0	0	0	0
Bck-1	0	0	0	0	0	0	0
Bck-2	0	0	0	0	0	0	0
Bck-3	0	0	0	0	0	0	0
Pe-1	0	0	0	0	0	0	0
R-1	0	0	0	0	0	0	0
R-2	0	0	0	0	0	0	0
R-3	0	0	0	0	0	0	0
PM-1	0	0	0	0	0	0	0
PM-2	0	0	0	0	0	0	0
DW5-1	0	0	0	0	0	0	0
DW5-2	0	0	0	0	0	0	0
DW5-3	0	0	0	0	0	0	0
A-1	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (45/51)

No. ID	Beam Transverse Reinf.						
	Whole Section						
	Length [mm]	f_y [MPa]	s_{hz}[mm]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
DW7-1	whole	336.47	88.9	2	9.53	0	0
DW7-2	whole	336.47	88.9	2	9.53	0	0
DW7-3	whole	336.47	88.9	2	9.53	0	0
Ge-1	0	0	0	0	0	0	0
Ge-2	0	0	0	0	0	0	0
Ge-3	0	0	0	0	0	0	0
Ge-4	0	0	0	0	0	0	0
L-1	0	0	0	0	0	0	0
L-2	0	0	0	0	0	0	0
FA-1	0	0	0	0	0	0	0
FA-2	0	0	0	0	0	0	0
FA-3	0	0	0	0	0	0	0
FA-4	0	0	0	0	0	0	0
Ae-1	0	0	0	0	0	0	0
Ae-2	0	0	0	0	0	0	0
Ae-3	0	0	0	0	0	0	0
Ae-4	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (46/51)

No.ID	Dimension						Reinforcement							
	thickness	f’c	Along loading-dir		Perpendicular to loading dir		Along loading-direction				Perpendicular to loading-direction			
			L_{slab_left} [mm]	L_{slab_right} [mm]	L_{slab_north} [mm]	L_{slab_south} [mm]	Top Reinf		Bot Reinf.		Top Reinf		Bot Reinf.	
							d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]
H-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MJ-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (47/51)

No.ID	Dimension						Reinforcement							
	thickness	f’c	Along loading-dir		Perpendicular to loading dir		Along loading-direction				Perpendicular to loading-direction			
			L_{slab_left} [mm]	L_{slab_right} [mm]	L_{slab_north} [mm]	L_{slab_south} [mm]	Top Reinf		Bot Reinf.		Top Reinf		Bot Reinf.	
							d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]
B-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ve-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ve-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bck-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pe-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PM-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PM-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DW5-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (48/51)

No.ID	Dimension						Reinforcement							
	thickness	f’c	Along loading-dir		Perpendicular to loading dir		Along loading-direction				Perpendicular to loading-direction			
			L_{slab_left} [mm]	L_{slab_right} [mm]	L_{slab_north} [mm]	L_{slab_south} [mm]	Top Reinf		Bot Reinf.		Top Reinf		Bot Reinf.	
							d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]
DW7-1	101.6	41.58	1248	1248	367	367	12.7	100	0	0	12.7	100	0	0
DW7-2	101.6	30.75	1248	1248	367	367	12.7	100	0	0	12.7	100	0	0
DW7-3	101.6	28.27	1248	1248	367	367	12.7	100	0	0	12.7	100	0	0
Ge-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ge-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FA-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ae-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A2 — Database storage for concentric-interior beam-column joints (49/51)

No. ID	Failure Mode	Column axial load [%Agf’c]	Maximum Loading				Loading Curve								
			Positive		Negative		Type of Loading	Positive Loading				Negative Loading			
			P_{max}[kN]	Drift[%]	P_{max}[kN]	Drift[%]		$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$	$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$
H-1	BF	50.43	130.00	2.30	78.50	1.60	II	119.00	124.00	129.00	122.00	76.90	77.70	78.00	-
H-2	BF	57.94	134.00	1.60	89.60	1.00	II	95.30	126.00	133.00	-	80.30	86.30	86.60	73.10
MJ-1	J	39.47	98.60	1.56	80.50	1.56	II	59.00	79.10	94.10	72.70	51.30	67.00	76.50	63.90
MJ-2	J	24.75	156.80	2.66	102.00	2.19	II	66.20	76.50	144.00	138.00	52.90	76.50	101.00	93.50
MJ-3	J	38.86	112.00	1.35	86.00	1.67	II	63.30	92.00	110.00	106.00	58.30	72.10	83.30	74.50
MJ-4	J	28.68	143.00	2.60	124.00	3.13	II	58.50	72.10	122.00	135.00	52.80	65.50	86.70	86.60
MJ-5	J	3.86	156.80	2.71	98.60	2.29	II	47.20	81.70	128.00	138.00	41.50	54.60	76.00	86.60
MJ-6	BJ	46.90	171.00	2.81	103.00	2.40	II	61.00	105.00	151.00	139.00	52.70	66.90	78.20	87.60
MJ-7	J	46.30	143.60	1.56	94.00	2.29	II	56.50	86.60	125.00	134.00	55.00	71.10	86.30	85.60
MJ-8	BJ	31.25	185.00	2.60	115.00	2.30	II	52.10	98.7	150.00	182.00	56.30	65.30	87.70	111.00
MJ-9	J	33.33	170.00	2.70	105.00	2.50	II	60.30	91.00	131.00	166.00	62.50	76.70	96.20	103.00
MJ-10	J	34.96	145.00	2.40	86.00	2.40	II	60.00	93.60	129.00	140.00	53.30	64.00	74.50	83.3.00
MJ-11	J	40.32	130.00	2.50	87.00	2.70	II	41.40	67.10	96.60	127.00	48.70	55.00	68.80	84.4.00
MJ-12	BJ	29.41	215.00	2.92	112.00	3.65	II	63.60	129.00	179.00	182.00	42.80	84.50	103.00	111.00
MJ-13	J	25.04	157.00	2.60	105.00	2.19	II	52.90	90.00	139.00	121.00	51.20	77.00	98.30	94.30
MJ-14	J	31.18	152.00	4.27	95.00	2.92	II	48.30	72.50	111.00	144.00	45.20	57.50	79.80	93.50
FI-1	BJ	0.00	53	1.2	48	1.2	II	31.20	49.50	50.00	51.00	35.10	43.50	47.20	45.30
FI-2	BJ	0.00	44	2.8	43	2.7	II	31.10	42.40	43.60	42.50	32.30	38.70	42.00	37.40

Table A2 — Database storage for concentric-interior beam-column joints (50/51)

No. ID	Failure Mode	Column axial load [%Agf’c]	Maximum Loading				Loading Curve								
			Positive		Negative		Type of Loading	Positive Loading				Negative Loading			
			P_{max}[kN]	Drift[%]	P_{max}[kN]	Drift[%]		$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$	$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$
B-1	BJ	BJ	156.00	1.76	162.00	1.82	II	112.00	140.00	155.00	-	65.70	133.00	158.00	-
B-2	BJ	BJ	142.00	1.57	162.00	1.58	II	124.00	140.00	140.00	-	122.00	149.00	155.00	-
Ve-1	BF	36.04	200	4.22	200.00	4.72	II	111.00	178.00	184.00	203.00	125.00	165.00	180.00	198.00
Ve-2	BF	34.92	208	4.88	204.00	5.00	II	151.00	185.00	193.00	215.00	160.00	167.00	182.00	204.00
Bck-1	BF	5.00	197	3.80	205.00	3.43	I	126.00	166.00	176.00	-	130.00	160.00	177.00	-
Bck-2	BF	5.00	-198	3.50	-200	3.60	I	121.00	169.00	181.00	-	156.00	167.00	182.00	-
Bck-3	BF	5.00	156	0.50	150.00	1.13	I	157.00	151.00	143.00	-	148.00	151.00	146.00	-
Pe-1	BJ	23.66	73.50	2.00	67.70	2.00	II	41.10	64.10	73.50	70.40	40.40	58.20	67.70	62.60
R-1	J	22.50	172.00	0.89	164.00	1.74	I	156.00	172.00	-	-	153.00	162.00	-	-
R-2	J	21.16	151.00	1.04	148.00	0.95	I	147.00	149.00	-	-	139.00	146.00	-	-
R-3	J	25.50	176.00	1.03	185.00	1.05	I	162.00	174.00	155.00	-	167.00	185.00	155.00	-
PM-1	BJ	10.00	67.90	4.18	76.00	4.36	II	45.90	60.10	66.30	66.80	45.00	62.00	68.90	73.50
PM-2	BJ	10.00	73.00	5.26	80.00	3.09	II	47.00	56.80	69.60	74.70	45.80	60.40	74.30	78.70
DW5-1	BJ	6.38	440.00	1.60	470.00	1.80	I	245.00	386.00	438.00	387.00	287.00	406.00	465.00	365.00
DW5-2	BJ	6.05	459.00	2.20	450.00	2.30	I	216.00	377.00	458.00	459.00	267.00	384.00	446.00	464.00
DW5-3	BJ	4.96	452.00	1.80	441.00	2.10	I	265.00	408.00	448.00	437.00	136.00	250.00	418.00	434.00
A-1	BJ	0.00	129.00	2.30	131.00	2.20	I	98.70	122.00	128.00	-	89.30	115.00	130.00	-

Table A2 — Database storage for concentric-interior beam-column joints (51/51)

No. ID	Failure Mode	Column axial load [%Agf’c]	Maximum Loading				Loading Curve								
			Positive		Negative		Type of Loading	Positive Loading				Negative Loading			
			P_{max}[kN]	Drift[%]	P_{max}[kN]	Drift[%]		$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$	$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$
DW7-1	BF	7.98	275	4	295	5.5	I	98.2	126	214	274	78.1	117	209	290
DW7-2	BF	8.41	279	4	296	5	I	50	109	222	279	85.3	132	242	290
DW7-3	BF	6.49	226	3.5	235	3.9	I	79.6	126	203	225	55	94	189	234
Ge-1	BF	16.67	65.9	1.80	65.00	1.70	I	54.60	57.00	59.30	64.20	54.30	56.00	60.10	64.00
Ge-2	BF	16.67	67.6	1.60	67.00	1.60	I	54.60	60.60	65.10	61.30	54.30	61.00	66.20	60.50
Ge-3	BF	16.67	63.5	1.40	63.00	1.40	I	54.60	58.30	62.50	63.60	54.30	57.00	61.50	62.00
Ge-4	BF	16.67	67.6	1.60	65.00	1.50	I	54.60	58.00	57.70	61.80	54.30	56.00	55.00	62.00
L-1	BJ	0.00	51.20	5.64	49.30	4.83	I	13.80	21.20	41.50	46.80	11.10	24.00	38.00	49.60
L-2	BJ	0.00	59.70	4.46	55.10	3.51	I	27.00	44.80	52.20	60.60	23.80	39.30	50.00	53.30
FA-1	J	7.71	50.00	3.00	48.00	3.00	II	22.00	35.00	44.00	47.00	22.00	34.00	41.00	44.00
FA-2	J	7.71	45.00	3.50	40.00	3.50	II	21.50	33.00	39.00	43.00	22.00	33.00	38.00	40.00
FA-3	J	23.14	50.00	3.00	47.00	3.00	II	32.00	43.00	49.00	48.00	21.00	30.00	38.00	41.00
FA-4	J	23.14	51.00	2.80	50.00	2.80	II	24.00	36.50	43.00	45.00	25.00	34.00	41.00	45.00
Ae-1	J	0.00	80.00	4.50	74.00	4.30	I	30.00	45.00	65.00	76.50	32.00	41.00	64.00	71.00
Ae-2	J	30.00	90.00	2.20	80.00	2.80	I	34.00	60.50	85.50	87.50	45.50	61.50	77.50	74.00
Ae-3	J	0.00	95.00	4.00	90.00	4.00	I	25.50	42.00	70.50	86.00	29.50	43.00	70.50	84.50
Ae-4	J	30.00	96.00	3.20	94.00	3.70	I	37.50	60.00	86.50	92.00	36.50	55.50	86.50	89.00

Table A3 — Database storage for concentric-interior beam-column joints (1/51)

No. ID	Authors	Spec. ID	Column Dimension							
			Upper Column		Lower Column		b_c[mm]	h_c[mm]	Cover-x [mm]	Cover-y [mm]
			L_column_u [mm]	f_c'[MPa]	L_column_lw [mm]	f_c'[MPa]				
H-4	Hanson (1971)	S4	1524	35.92	1524	38.89	381	381	56	56
H-5		S5	1524	37.37	1524	33.85	381	381	56	56
Ye-1	Yamaguchi et al (1980)	N22	1275	25.68	1275	25.68	500	500	40	40
Ye-2		N25	1275	21.95	1275	21.95	500	500	40	40
Ye-3		N29	1275	22.15	1275	22.15	500	500	40	40
Ye-4		N35	1275	23.03	1275	23.03	500	500	40	40
Ye-5		L25	1275	23.13	1275	23.13	500	500	40	40
Ye-6		2P13	690	22.93	690	22.93	270	270	40	40
Ye-7		2P16	690	21.85	690	21.85	270	270	40	40
Ye-8		4P16	690	23.42	690	23.42	270	270	40	40
Ye-9		2P19	690	21.95	690	21.95	270	270	40	40
Ye-10		S16	690	22.54	690	22.54	270	270	40	40
Pa-1	Paulay (1981)	Unit 1	1715	22.60	1715	22.60	457	457	35	35
Pa-2		Unit 2	1715	22.50	1715	22.50	457	457	35	35
Pa-3		Unit 3	1715	26.90	1715	26.90	457	457	35	35
Ka-1	Kanada (1984)	U40L	750	24.30	750	24.30	300	300	30	30
Ka-2		U41L	750	26.66	750	26.66	300	300	30	30
Ka-3		U42L	750	30.09	750	30.09	300	300	30	30

Table A3 — Database storage for concentric-interior beam-column joints (2/51)

No. ID	Authors	Spec. ID	Column Dimension							
			Upper Column		Lower Column		b_c[mm]	h_c[mm]	Cover-x [mm]	Cover-y [mm]
			L_column_u [mm]	f_c'[MPa]	L_column_lw [mm]	f_c'[MPa]				
EW5-1	Ehsani and Wight (1985)	Spec 1B	1066.8	33.58	1066.8	33.58	299.72	299.72	55.88	55.88
EW5-2		Spec 3B	1066.8	40.89	1066.8	40.89	299.72	299.72	55.88	55.88
EW5-3		Spec 4B	1066.8	44.61	1066.8	44.61	299.72	299.72	55.88	55.88
EW5-4		Spec 5B	1104.9	24.34	1104.9	24.34	340.36	340.36	50.8	50.8
EW5-5		Spec 6B	1104.9	39.78	1104.9	39.78	340.36	340.36	50.8	50.8
EW7-1	Ehsani and Wight (1987)	Spec 1	1727.2	64.67	1727.2	64.67	340.36	340.36	50.8	50.8
EW7-2		Spec 2	1727.2	67.29	1727.2	67.29	340.36	340.36	50.8	50.8
EW7-3		Spec 3	1727.2	64.67	1727.2	64.67	299.72	299.72	50.8	50.8
EW7-4		Spec 4	1727.2	67.29	1727.2	67.29	299.72	299.72	50.8	50.8
Al-1	Alameddine (1990)	LL8	1790.7	56.54	1790.7	56.54	355.6	355.6	63.5	63.5
Al-2		LH8	1790.7	56.54	1790.7	56.54	355.6	355.6	63.5	63.5
Al-3		HL8	1790.7	56.54	1790.7	56.54	355.6	355.6	63.5	63.5
Al-4		HH8	1790.7	56.54	1790.7	56.54	355.6	355.6	63.5	63.5
Al-5		LL11	1790.7	74.46	1790.7	74.46	355.6	355.6	63.5	63.5
Al-6		LH11	1790.7	74.46	1790.7	74.46	355.6	355.6	63.5	63.5
Al-7		HL11	1790.7	74.46	1790.7	74.46	355.6	355.6	63.5	63.5
Al-8		HH11	1790.7	74.46	1790.7	74.46	355.6	355.6	63.5	63.5
Al-9		LL14	1790.7	96.53	1790.7	96.53	355.6	355.6	63.5	63.5
Al-10		LH14	1790.7	96.53	1790.7	96.53	355.6	355.6	63.5	63.5
Al-11		HH14	1790.7	96.53	1790.7	96.53	355.6	355.6	63.5	63.5

Table A3 — Database storage for concentric-interior beam-column joints (3/51)

No. ID	Authors	Spec. ID	Column Dimension							
			Upper Column		Lower Column		b_c[mm]	h_c[mm]	Cover-x [mm]	Cover-y [mm]
			L_column_u [mm]	f_c'[MPa]	L_column_lw [mm]	f_c'[MPa]				
FB-1	Fujii and Morita (1991)	B1	750	29.99	750	29.99	220	220	30	30
FB-2		B2	750	29.99	750	29.99	220	220	30	30
FB-3		B3	750	29.99	750	29.99	220	220	30	30
FB-4		B4	750	29.99	750	29.99	220	220	30	30
Ce-1	Castro (2004)	A-No.1	732	50.00	732	50.00	400	400	45	45
Ce-2		A-No.2	732	70.00	732	70.00	400	400	45	45
Ce-3		A-No.5	732	21.00	732	21.00	400	400	45	45
Ce-4		B-No.7	732	50.00	732	50.00	400	400	45	45
Ce-5		B-No.10	732	50.00	732	50.00	400	400	45	45
He-1	Hwang et al. (2005)	3T44	1125	76.80	1125	76.80	420	420	40	40
He-2		3T3	1125	69.00	1125	69.00	420	420	40	40
He-3		2T4	1125	71.00	1125	71.00	420	420	40	40
He-4		1T44	1125	72.80	1125	72.80	420	420	40	40
He-5		3T4	1125	75.20	1125	75.20	450	450	40	40
He-6		2T5	1125	76.60	1125	76.60	450	450	40	40
He7		1T55	1125	69.70	1125	69.70	450	450	40	40
LK-1	Lee and Ko (2007)	S0	1125	28.50	1125	28.50	400	600	50	50
LK-2		W0	1125	25.20	1125	25.20	600	400	50	50

Table A3 — Database storage for concentric-exterior beam-column joints (4/51)

No. ID	Arrangement of Column Longitudinal Reinforcement-1																		
	1st layer							2nd layer				3rd layer				4th layer			
		Corner bar			Intermediate Bar			Side Bar				Side Bar				Side Bar			
	d_1 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	d_3 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	d_4 [mm]	n	d_{bar} [mm]	f_y $[MPa]$
H-4	325	2	35.8	419.20	1	35.8	419.20	190.5	2	35.6	419.20	0	0	0	0	0	0	0	0
H-5	325	2	35.8	419.20	1	35.8	419.20	190.5	2	35.6	419.20	0	0	0	0	0	0	0	0
Ye-1	460	2	25.4	350.00	2	25.4	350.00	250	2	25.4	350.00	0	0	0	0	0	0	0	0
Ye-2	460	2	25.4	350.00	2	25.4	350.00	250	2	25.4	350.00	0	0	0	0	0	0	0	0
Ye-3	460	2	25.4	350.00	2	25.4	350.00	250	2	25.4	350.00	0	0	0	0	0	0	0	0
Ye-4	460	2	25.4	350.00	2	25.4	350.00	250	2	25.4	350.00	0	0	0	0	0	0	0	0
Ye-5	460	2	25.4	350.00	2	25.4	350.00	250	2	25.4	350.00	0	0	0	0	0	0	0	0
Ye-6	230	2	16	350.00	1	16	350.00	135	2	16	350.00	0	0	0	0	0	0	0	0
Ye-7	230	2	16	350.00	1	16	350.00	135	2	16	350.00	0	0	0	0	0	0	0	0
Ye-8	230	2	16	350.00	1	16	350.00	135	2	16	350.00	0	0	0	0	0	0	0	0
Ye-9	230	2	16	350.00	1	16	350.00	135	2	16	350.00	0	0	0	0	0	0	0	0
Ye-10	230	2	16	350.00	1	16	350.00	135	2	16	350.00	0	0	0	0	0	0	0	0
Pa-1	422	2	20	296.00	2	20	296.00	317	2	20	296.00	140	2	20	296.00	0	0	0	0
Pa-2	422	2	20	296.00	2	20	296.00	317	2	20	296.00	140	2	20	296.00	0	0	0	0
Pa-3	422	2	20	296.00	2	20	296.00	317	2	20	296.00	140	2	20	296.00	0	0	0	0
Ka-1	325	2	22	385.14	0	0	0.00	150	1	22	385.14	0	0	0	0.00	0	0	0	0
Ka-2	325	2	22	385.14	0	0	0.00	150	1	22	385.14	0	0	0	0.00	0	0	0	0
Ka-3	325	2	22	385.14	0	0	0.00	150	1	22	385.14	0	0	0	0.00	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (5/51)

No. ID	Arrangement of Column Longitudinal Reinforcement-1																		
	1st layer							2nd layer				3rd layer				4th layer			
		Corner bar			Intermediate Bar			Side Bar				Side Bar				Side Bar			
	d_1 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	d_3 [mm]	n	d_{bar} [mm]	f_y $[MPa]$	d_4 [mm]	n	d_{bar} [mm]	f_y $[MPa]$
EW5-1	243.84	2	19.1	489.53	1	19.1	489.53	149.86	2	19.1	489.53	0	0	0	0.00	0	0	0	0
EW5-2	243.84	2	19.1	489.53	1	19.1	489.53	149.86	2	19.1	489.53	0	0	0	0.00	0	0	0	0
EW5-3	243.84	2	19.1	489.53	1	19.1	489.53	149.86	2	19.1	489.53	0	0	0	0.00	0	0	0	0
EW5-4	289.56	2	25.4	413.69	1	25.4	413.69	170.18	2	25.4	413.69	0	0	0	0.00	0	0	0	0
EW5-5	289.56	2	19.1	489.53	1	19.1	489.53	170.18	2	19.1	489.53	0	0	0	0.00	0	0	0	0
EW7-1	289.56	2	22.2	455.06	1	19.1	455.06	170.18	2	19.1	455.06	0	0	0	0.00	0	0	0	0
EW7-2	289.56	2	22.2	455.06	1	19.1	455.06	170.18	2	19.1	455.06	0	0	0	0.00	0	0	0	0
EW7-3	248.92	2	22.2	455.06	1	19.1	455.06	149.86	2	19.1	455.06	0	0	0	0.00	0	0	0	0
EW7-4	248.92	2	25.4	455.06	1	22.2	455.06	149.86	2	22.2	455.06	0	0	0	0.00	0	0	0	0
Al-1	292.1	2	25.4	456.99	1	22.2	479.19	177.8	2	22.2	479.19	0	0	0	0.00	0	0	0	0
Al-2	292.1	2	25.4	456.99	1	22.2	479.19	177.8	2	22.2	479.19	0	0	0	0.00	0	0	0	0
Al-3	292.1	2	25.4	456.99	1	25.4	456.99	177.8	2	25.4	456.99	0	0	0	0.00	0	0	0	0
Al-4	292.1	2	25.4	456.99	1	25.4	456.99	177.8	2	25.4	456.99	0	0	0	0.00	0	0	0	0
Al-5	292.1	2	25.4	456.99	1	22.2	479.19	177.8	2	22.2	479.19	0	0	0	0.00	0	0	0	0
Al-6	292.1	2	25.4	456.99	1	22.2	479.19	177.8	2	22.2	479.19	0	0	0	0.00	0	0	0	0
Al-7	292.1	2	25.4	456.99	1	25.4	456.99	177.8	2	25.4	456.99	0	0	0	0.00	0	0	0	0
Al-8	292.1	2	25.4	456.99	1	25.4	456.99	177.8	2	25.4	456.99	0	0	0	0.00	0	0	0	0
Al-9	292.1	2	25.4	456.99	1	22.2	479.19	177.8	2	22.2	479.19	0	0	0	0.00	0	0	0	0
Al-10	292.1	2	25.4	456.99	1	22.2	479.19	177.8	2	22.2	479.19	0	0	0	0.00	0	0	0	0
Al-11	292.1	2	25.4	456.99	1	25.4	456.99	177.8	2	25.4	456.99	0	0	0	0.00	0	0	0	0

Table A3 — Database storage for concentrice-xterior beam-column joints (6/51)

No. ID	Arrangement of Column Longitudinal Reinforcement-1																		
	1st layer							2nd layer				3rd layer				4th layer			
		Corner bar			Intermediate Bar			Side Bar				Side Bar				Side Bar			
	d_1 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	d_2 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_3 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_4 [mm]	n	d_{bar} [mm]	f_y [MPa]
FB-1	190	2	12.7	387.10	2	12.7	387.10	150	2	13	387.10	110	2	13	387.10	0	0	0	0
FB-2	190	2	12.7	387.10	2	12.7	387.10	150	2	13	387.10	110	2	13	387.10	0	0	0	0
FB-3	190	2	12.7	387.10	2	12.7	387.10	150	2	13	387.10	110	2	13	387.10	0	0	0	0
FB-4	190	2	12.7	387.10	2	12.7	387.10	150	2	13	387.10	110	2	13	387.10	0	0	0	0
Ce-1	355	2	22	571.00	2	22	571.00	230	2	22	571.00	170	2	22	571.00	0	0	0	0
Ce-2	355	2	22	571.00	2	22	571.00	230	2	22	571.00	170	2	22	571.00	0	0	0	0
Ce-3	355	2	22	571.00	2	22	571.00	230	2	22	571.00	170	2	22	571.00	0	0	0	0
Ce-4	355	2	22	571.00	2	22	571.00	230	2	22	571.00	170	2	22	571.00	0	0	0	0
Ce-5	355	2	22	571.00	2	22	571.00	230	2	22	571.00	170	2	22	571.00	0	0	0	0
He-1	380	2	32.2	421.00	1	32.2	421.00	210	2	32.2	421.00	0	0	0	0.00	0	0	0	0
He-2	380	2	32.2	421.00	1	32.2	421.00	210	2	32.2	421.00	0	0	0	0.00	0	0	0	0
He-3	380	2	32.2	421.00	1	32.2	421.00	210	2	32.2	421.00	0	0	0	0.00	0	0	0	0
He-4	380	2	32.2	421.00	1	32.2	421.00	210	2	32.2	421.00	0	0	0	0.00	0	0	0	0
He-5	410	2	32.2	458.00	1	32.2	458.00	225	2	32.2	458.00	0	0	0	0.00	0	0	0	0
He-6	410	2	32.2	458.00	1	32.2	458.00	225	2	32.2	458.00	0	0	0	0.00	0	0	0	0
He7	410	2	32.2	458.00	1	32.2	458.00	225	2	32.2	458.00	0	0	0	0.00	0	0	0	0
LK-1	550	2	22	455.00	1	22	455.00	425	2	22	455.00	300	2	22	455.00	175	2	22	455
LK-2	350	2	22	455.00	3	22	455.00	200	2	22	455.00	0	0	0	0.00	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (7/51)

No. ID	Arrangement of Column Longitudinal Reinforcement														
	5th layer				6th layer				7th layer						
	Side Bar				Side Bar					Corner Bar			Intermediate Bar		
	d_5 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_6 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_7 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
H-4	0	0	0	0	0	0	0	0	56	2	11	419.20	1	11	419.20
H-5	0	0	0	0	0	0	0	0	56	2	11	419.20	1	11	419.20
Ye-1	0	0	0	0	0	0	0	0	40	2	25.4	350	2	25.4	350.00
Ye-2	0	0	0	0	0	0	0	0	40	2	25.4	350	2	25.4	350.00
Ye-3	0	0	0	0	0	0	0	0	40	2	25.4	350	2	25.4	350.00
Ye-4	0	0	0	0	0	0	0	0	40	2	25.4	350	2	25.4	350.00
Ye-5	0	0	0	0	0	0	0	0	40	2	25.4	350	2	25.4	350.00
Ye-6	0	0	0	0	0	0	0	0	40	2	16	350	1	16	350.00
Ye-7	0	0	0	0	0	0	0	0	40	2	16	350	1	16	350.00
Ye-8	0	0	0	0	0	0	0	0	40	2	16	350	1	16	350.00
Ye-9	0	0	0	0	0	0	0	0	40	2	16	350	1	16	350.00
Ye-10	0	0	0	0	0	0	0	0	40	2	16	350	1	16	350.00
Pa-1	0	0	0	0	0	0	0	0	35	2	20	296.00	2	20	296.00
Pa-2	0	0	0	0	0	0	0	0	35	2	20	296.00	2	20	296.00
Pa-3	0	0	0	0	0	0	0	0	35	2	20	296.00	2	20	296.00
Ka-1	0	0	0	0	0	0	0	0	30	2	22	385.14	0	0	0.00
Ka-2	0	0	0	0	0	0	0	0	30	2	22	385.14	0	0	0.00
Ka-3	0	0	0	0	0	0	0	0	30	2	22	385.14	0	0	0.00

Table A3 — Database storage for concentric-exterior beam-column joints (8/51)

No. ID	Arrangement of Column Longitudinal Reinforcement														
	5th layer				6th layer				7th layer						
	Side Bar				Side Bar					Corner Bar			Intermediate Bar		
	d_5 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_6 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_7 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
EW5-1	0	0	0	0	0	0	0	0	55.88	2	19.1	489.53	1	19.1	489.53
EW5-2	0	0	0	0	0	0	0	0	55.88	2	19.1	489.53	1	19.1	489.53
EW5-3	0	0	0	0	0	0	0	0	55.88	2	19.1	489.53	1	19.1	489.53
EW5-4	0	0	0	0	0	0	0	0	50.8	2	25.4	413.69	1	25.4	413.69
EW5-5	0	0	0	0	0	0	0	0	50.8	2	19.1	489.53	1	19.1	489.53
EW7-1	0	0	0	0	0	0	0	0	50.8	2	22.2	455.06	1	19.1	455.06
EW7-2	0	0	0	0	0	0	0	0	50.8	2	22.2	455.06	1	19.1	455.06
EW7-3	0	0	0	0	0	0	0	0	50.8	2	22.2	455.06	1	19.1	455.06
EW7-4	0	0	0	0	0	0	0	0	50.8	2	25.4	455.06	1	22.2	455.06
Al-1	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	22.2	479.19
Al-2	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	22.2	479.19
Al-3	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	25.4	456.99
Al-4	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	25.4	456.99
Al-5	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	22.2	479.19
Al-6	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	22.2	479.19
Al-7	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	25.4	456.99
Al-8	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	25.4	456.99
Al-9	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	22.2	479.19
Al-10	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	22.2	479.19
Al-11	0	0	0	0	0	0	0	0	63.5	2	25.4	456.99	1	25.4	456.99

Table A3 — Database storage for concentric-exterior beam-column joints (9/51)

No. ID	Arrangement of Column Longitudinal Reinforcement														
	5th layer				6th layer				7th layer						
	Side Bar				Side Bar					Corner Bar			Intermediate Bar		
	d_5 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_6 [mm]	n	d_{bar} [mm]	f_y [MPa]	d_7 [mm]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
FB-1	0	0	0	0	0	0	0	0	30	2	13	387.10	2	13	387.10
FB-2	0	0	0	0	0	0	0	0	30	2	13	387.10	2	13	387.10
FB-3	0	0	0	0	0	0	0	0	30	2	13	387.10	2	13	387.10
FB-4	0	0	0	0	0	0	0	0	30	2	13	387.10	2	13	387.10
Ce-1	0	0	0	0	0	0	0	0	45	2	22	571.00	2	22	571.00
Ce-2	0	0	0	0	0	0	0	0	45	2	22	571.00	2	22	571.00
Ce-3	0	0	0	0	0	0	0	0	45	2	22	571.00	2	22	571.00
Ce-4	0	0	0	0	0	0	0	0	45	2	22	571.00	2	22	571.00
Ce-5	0	0	0	0	0	0	0	0	45	2	22	571.00	2	22	571.00
He-1	0	0	0	0	0	0	0	0	50	2	32.2	421.00	1	32.2	421.00
He-2	0	0	0	0	0	0	0	0	50	2	32.2	421.00	1	32.2	421.00
He-3	0	0	0	0	0	0	0	0	50	2	32.2	421.00	1	32.2	421.00
He-4	0	0	0	0	0	0	0	0	50	2	32.2	421.00	1	32.2	421.00
He-5	0	0	0	0	0	0	0	0	50	2	32.2	458.00	1	32.2	458.00
He-6	0	0	0	0	0	0	0	0	50	2	32.2	458.00	1	32.2	458.00
He7	0	0	0	0	0	0	0	0	50	2	32.2	458.00	1	32.2	458.00
LK-1	0	0	0	0	0	0	0	0	50	2	22	455.00	1	32.2	715.00
LK-2	0	0	0	0	0	0	0	0	50	2	22	455.00	3	22	455.00

Table A3 — Database storage for concentric- exterior beam-column joints (10/51)

No. ID	Transverse Reinforcement - 1														
	Type of Hz. Reinf.	Column 1^{st} section (closer to joint)													
		Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
				n-set	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
H-4	1	whole	76.2	1	12.7	506.77	0	0	0.00	0	0	0	0	0	0
H-5	1	whole	76.2	1	12.7	506.77	0	0	0.00	0	0	0	0	0	0
Ye-1	1	whole	100	1	13	240.00	0	0	0.00	0	0	0	0	0	0
Ye-2	1	whole	100	1	13	240.00	0	0	0.00	0	0	0	0	0	0
Ye-3	1	whole	100	1	13	240.00	0	0	0.00	0	0	0	0	0	0
Ye-4	1	whole	100	1	13	240.00	0	0	0.00	0	0	0	0	0	0
Ye-5	1	whole	100	1	13	240.00	0	0	0.00	0	0	0	0	0	0
Ye-6	1	whole	60	1	6	300.00	0	0	0.00	0	0	0	0	0	0
Ye-7	1	whole	60	1	6	300.00	0	0	0.00	0	0	0	0	0	0
Ye-8	1	whole	60	1	6	300.00	0	0	0.00	0	0	0	0	0	0
Ye-9	1	whole	60	1	6	300.00	0	0	0.00	0	0	0	0	0	0
Ye-10	1	whole	60	1	6	300.00	0	0	0.00	0	0	0	0	0	0
Pa-1	2	800	120	1	10	316.00	2	10	316.00	2	10	316	0	0	0
Pa-2	2	800	120	1	10	316.00	2	10	316.00	2	10	316	0	0	0
Pa-3	2	800	120	1	10	316.00	2	10	316.00	2	10	316	0	0	0
Ka-1	1	whole	100	1	9	294.00	0	0	0.00	0	0	0	0	0	0
Ka-2	1	whole	100	1	9	294.00	0	0	0.00	0	0	0	0	0	0
Ka-3	1	whole	100	1	9	294.00	0	0	0.00	0	0	0	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (11/51)

No. ID	Transverse Reinforcement - 1														
	Type of Hz. Reinf.	Column 1st section (closer to joint)													
		Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
				n-set	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
EW5-1	6	whole	N/A	1	12.7	437.13	0	0	0.00	0	0	0.00	1	12.7	437.13
EW5-2	6	whole	N/A	1	12.7	437.13	0	0	0.00	0	0	0.00	1	12.7	437.13
EW5-3	7	whole	N/A	1	12.7	437.13	0	0	0.00	0	0	0.00	1	12.7	437.13
EW5-4	7	whole	N/A	1	12.7	437.13	0	0	0.00	0	0	0.00	1	12.7	437.13
EW5-5	6	whole	N/A	1	12.7	437.13	0	0	0.00	0	0	0.00	1	12.7	437.13
EW7-1	6	whole	93.98	1	12.7	455.06	0	0	0.00	0	0	0.00	1	12.7	455.06
EW7-2	6	whole	93.98	1	12.7	455.06	0	0	0.00	0	0	0.00	1	12.7	455.06
EW7-3	6	whole	93.98	1	12.7	455.06	0	0	0.00	0	0	0.00	1	12.7	455.06
EW7-4	6	whole	93.98	1	12.7	455.06	0	0	0.00	0	0	0.00	1	12.7	455.06
Al-1	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-2	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-3	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-4	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-5	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-6	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-7	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-8	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-9	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-10	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00
Al-11	3	whole	63.5	1	12.7	446.44	1	12.7	446.44	0	0	0.00	0	0	0.00

Table A3 — Database storage for concentric-exterior beam-column joints (12/51)

No. ID	Transverse Reinforcement - 1														
	Type of Hz. Reinf.	Column 1^{st} section (closer to joint)													
		Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
				n-set	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]
FB-1	5	whole	?	1	6	291.06	0	0	0.00	0	0	0.00	0	0	0
FB-2	5	whole	?	1	6	291.06	0	0	0.00	0	0	0.00	0	0	0
FB-3	5	whole	?	1	6	291.06	0	0	0.00	0	0	0.00	0	0	0
FB-4	5	whole	?	1	6	291.06	0	0	0.00	0	0	0.00	0	0	0
Ce-1	4	whole	101.4	1	10	369.00	2	10	369.00	2	10	369.00	0	0	0
Ce-2	4	whole	101.4	1	10	369.00	2	10	369.00	2	10	369.00	0	0	0
Ce-3	4	whole	101.4	1	10	369.00	2	10	369.00	2	10	369.00	0	0	0
Ce-4	4	whole	101.4	1	10	369.00	2	10	369.00	2	10	369.00	0	0	0
Ce-5	4	whole	101.4	1	10	369.00	2	10	369.00	2	10	369.00	0	0	0
He-1	3	whole	97	1	12.7	498.00	1	12.7	498.00	1	12.7	498.00	0	0	0
He-2	3	whole	97	1	12.7	471.00	1	12.7	471.00	1	12.7	471.00	0	0	0
He-3	3	whole	97	1	12.7	498.00	0	0	0.00	0	0	0.00	0	0	0
He-4	3	whole	97	1	12.7	498.00	0	0	0.00	0	0	0.00	0	0	0
He-5	3	whole	97	1	12.7	436.00	1	12.7	436.00	1	12.7	436.00	0	0	0
He-6	3	whole	97	1	12.7	469.00	0	0	0.00	0	0	469.00	0	0	0
He7	3	whole	97	1	12.7	469.00	0	0	0.00	0	0	469.00	0	0	0
LK-1	3	whole	100	1	10	471.00	1	10	471.00	3	10	471.00	0	0	0
LK-2	3	whole	100	1	10	471.00	3	10	471.00	1	10	471.00	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (13/51)

No.ID	Transverse Reinforcement -2														
	Column 2nd section (closer to column end)														
	Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie			
			n-set	d_{bar} [mm]	f_y [MPa]	n	d_{bar}	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	n	d_{bar} [mm]	f_y [MPa]	
H-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
H-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ye-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pa-1	915	180	1	10	316.00	2	10	316.00	2	10	316.00	0	0	0.00	
Pa-2	915	180	1	10	316.00	2	10	316.00	2	10	316.00	0	0	0.00	
Pa-3	915	180	1	10	316.00	2	10	316.00	2	10	316.00	0	0	0.00	
Ka-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ka-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ka-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table A3 — Database storage for concentric- exterior beam-column joints (14/51)

No.ID	Transverse Reinforcement -2													
	Column 2^{nd} section (closer to column end)													
	Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
			n-set	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
EW5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (15/51)

No.ID	Transverse Reinforcement -2													
	Column 2nd section (closer to column end)													
	Length [mm]	s_{vert} [mm]	Outer Hoop			Tie in X (Loading) direction			Tie in Y Direction			Diagonal Tie		
			n-set	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
FB-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-interior beam-column joints (16/51)

No. ID	ecc. [mm]	Beam Dimension							
		Left Beam		Right Beam		b_b[mm]	h_b[mm]	cover-x[mm]	cover-y[mm]
		f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
H-4	0	0	0	37.09	3239	305	508	38.1	38.1
H-5	0	0	0	36.13	3239	305	508	38.1	38.1
Ye-1	0	0	0	25.68	1690	350	550	40	40
Ye-2	0	0	0	21.95	1690	350	550	40	40
Ye-3	0	0	0	22.15	1690	350	550	40	40
Ye-4	0	0	0	23.03	1690	350	550	40	40
Ye-5	0	0	0	23.13	1690	350	550	40	40
Ye-6	0	0	0	22.93	915	190	300	40	40
Ye-7	0	0	0	21.85	915	190	300	40	40
Ye-8	0	0	0	23.42	915	190	300	40	40
Ye-9	0	0	0	21.95	915	190	300	40	40
Ye-10	0	0	0	22.54	915	190	300	40	40
Pa-1	0	0	0	22.60	2429	356	610	35	35
Pa-2	0	0	0	22.50	2429	356	610	35	35
Pa-3	0	0	0	26.90	2429	356	610	35	35
Ka-1	0	0	0	24.30	900	260	383	50	50
Ka-2	0	0	0	26.66	900	260	384	50	50
Ka-3	0	0	0	30.09	900	260	385	50	50

Table A3 — Database storage for concentric-interior beam-column joints (17/51)

No. ID	ecc. [mm]	Beam Dimension							
		Left Beam		Right Beam		b_b[mm]	h_b[mm]	cover-x[mm]	cover-y[mm]
		f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
EW5-1	0	0	0	33.58	1674	259	480.06	50.8	50.8
EW5-2	0	0	0	40.89	1674	259	480.06	50.8	50.8
EW5-3	0	0	0	44.61	1674	259	439.42	48.26	48.26
EW5-4	0	0	0	24.34	897	300	480.06	50.8	50.8
EW5-5	0	0	0	39.78	897	300	480.06	50.8	50.8
EW7-1	0	0	0	64.67	1745	300	480.06	50.8	50.8
EW7-2	0	0	0	67.29	1745	300	480.06	50.8	50.8
EW7-3	0	0	0	64.67	1725	259	439.42	50.8	50.8
EW7-4	0	0	0	67.29	1725	259	439.42	50.8	50.8
Al-1	0	0	0	56.54	1778	318	508	73.025	73.025
Al-2	0	0	0	56.54	1778	318	508	73.025	73.025
Al-3	0	0	0	56.54	1778	318	508	76.2	76.2
Al-4	0	0	0	56.54	1778	318	508	76.2	76.2
Al-5	0	0	0	74.46	1778	318	508	63.5	63.5
Al-6	0	0	0	74.46	1778	318	508	69.85	69.85
Al-7	0	0	0	74.46	1778	318	508	66.675	66.675
Al-8	0	0	0	74.46	1778	318	508	69.85	69.85
Al-9	0	0	0	96.53	1778	318	508	73.025	73.025
Al-10	0	0	0	96.53	1778	318	508	73.025	73.025
Al-11	0	0	0	96.53	1778	318	508	79.375	79.375

Table A3 — Database storage for concentric-interior beam-column joints (18/51)

No. ID	ecc. [mm]	Beam Dimension							
		Left Beam		Right Beam		b_b[mm]	h_b[mm]	cover-x[mm]	cover-y[mm]
		f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
FB-1	0	0	0	29.99	1000	160	250	25	25
FB-2	0	0	0	29.99	1000	160	250	25	25
FB-3	0	0	0	29.99	1000	160	250	25	25
FB-4	0	0	0	29.99	1000	160	250	25	25
Ce-1	0	0	0	50.00	1950	350	450	50	55
Ce-2	0	0	0	70.00	1950	350	450	50	55
Ce-3	0	0	0	21.00	1950	350	450	50	55
Ce-4	0	0	0	50.00	1950	350	450	50	55
Ce-5	0	0	0	50.00	1950	350	450	50	55
He-1	0	0	0	76.80	2110	320	450	50	50
He-2	0	0	0	69.00	2110	320	450	50	50
He-3	0	0	0	71.00	2110	320	450	50	50
He-4	0	0	0	72.80	2110	320	450	50	50
He-5	0	0	0	75.20	2125	320	450	50	50
He-6	0	0	0	76.60	2125	320	450	50	50
He7	0	0	0	69.70	2125	320	450	50	50
LK-1	0	0	0	28.50	2150	300	450	50	50
LK-2	0	0	0	29.50	2150	300	450	50	50

Table A3 — Database storage for concentric-exterior beam-column joints (19/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-1																				
	1st layer										2nd layer							3rd layer			
	d_1 [mm]	Corner bar			Intermediate Bar			Inner Bar			d_2 [mm]	Outer bar			Inner Bar			d_3 [mm]	Outer + Inner Bar		
		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$
H-4	469.9	2	25.4	437.13	2	25.4	437.13	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
H-5	469.9	2	25.4	448.16	2	25.4	448.16	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Ye-1	510	2	22	350.00	3	22	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-2	510	2	25	350.00	2	25	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-3	510	2	29	350.00	1	29	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-4	510	2	35	350.00	0	0	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-5	510	2	25	350.00	2	25	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-6	260	2	13	350.00	3	13	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-7	260	2	16	350.00	1	16	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-8	260	2	16	350.00	1	16	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-9	260	2	19	350.00	0	19	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Ye-10	260	2	16	350.00	1	16	350.00	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0.00
Pa-1	575	2	20	296.00	2	20	296.00	0	0	0.00	550	2	20	296.00	0	0	0.00	0	0	0	0.00
Pa-2	575	2	24	300.00	2	20	296.00	0	0	0.00	550	2	20	296.00	2	20	296.00	0	0	0	0.00
Pa-3	575	2	20	296.00	2	20	296.00	0	0	0.00	550	2	20	296.00	0	0	0.00	0	0	0	0.00
Ka-1	333	2	19	387.10	2	19	387.10	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Ka-2	334	2	19	387.10	2	19	387.10	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Ka-3	335	2	19	387.10	2	19	387.10	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00

Table A3 — Database storage for concentric- exterior beam-column joints (20/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-1																				
	1st layer										2nd layer							3rd layer			
	d_1 [mm]	Corner bar			Intermediate Bar			Inner Bar			d_2 [mm]	Outer bar			Inner Bar			d_3 [mm]	Outer + Inner Bar		
		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$
EW5-1	429.26	2	22.2	330.95	1	22.2	330.95	0	0	0.00	381	2	19.1	344.74	1	19.1	344.74	0	0	0	0.00
EW5-2	429.26	2	22.2	330.95	1	22.2	330.95	0	0	0.00	381	2	19.1	344.74	1	19.1	344.74	0	0	0	0.00
EW5-3	391.16	2	22.2	330.95	1	22.2	330.95	0	0	0.00	340.36	2	19.1	344.74	1	19.1	344.74	0	0	0	0.00
EW5-4	429.26	2	22.2	330.95	1	22.2	330.95	0	0	0.00	381	2	19.1	344.74	1	19.1	344.74	0	0	0	0.00
EW5-5	429.26	2	22.2	330.95	1	22.2	330.95	0	0	0.00	381	2	19.1	344.74	1	19.1	344.74	0	0	0	0.00
EW7-1	429.26	2	19.1	455.06	1	15.9	455.06	0	0	0.00	381	2	15.9	455.06	0	0	0.00	0	0	0	0.00
EW7-2	429.26	2	19.1	455.06	1	19.1	455.06	0	0	0.00	381	2	19.1	455.06	0	0	0.00	0	0	0	0.00
EW7-3	388.62	2	19.1	455.06	1	19.1	455.06	0	0	0.00	340.36	2	15.9	455.06	0	0	0.00	0	0	0	0.00
EW7-4	388.62	2	22.2	455.06	1	22.2	455.06	0	0	0.00	340.36	2	15.9	455.06	0	0	0.00	0	0	0	0.00
Al-1	434.975	2	25.4	456.99	2	25.4	456.99	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-2	434.975	2	25.4	456.99	2	25.4	456.99	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-3	431.8	2	28.7	442.85	2	28.7	442.85	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-4	431.8	2	28.7	442.85	2	28.7	442.85	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-5	444.5	2	25.4	456.99	2	25.4	456.99	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-6	438.15	2	25.4	456.99	2	25.4	456.99	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-7	441.325	2	28.7	442.85	2	28.7	442.85	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-8	438.15	2	28.7	442.85	2	28.7	442.85	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-9	434.975	2	25.4	456.99	2	25.4	456.99	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-10	434.975	2	25.4	456.99	2	25.4	456.99	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Al-11	428.625	2	28.7	442.85	2	28.7	442.85	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00

Table A3 — Database storage for concentric-exterior beam-column joints (21/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-1																				
	1^{st} layer										2^{nd} layer							3^{rd} layer			
	d_1 [mm]	Corner bar			Intermediate Bar			Inner Bar			d_2 [mm]	Outer bar			Inner Bar			d_3 [mm]	Outer + Inner Bar		
		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar}	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$
FB-1	225	2	10	1068.20	2	10	1068.20	0	0	0.00	200	2	10	1068.20	2	10	1068.20	0	0	0	0.00
FB-2	225	2	10	408.66	2	10	408.66	0	0	0.00	200	2	10	408.66	2	10	408.66	0	0	0	0.00
FB-3	225	2	10	1068.20	2	10	1068.20	0	0	0.00	200	2	10	1068.20	2	10	1068.20	0	0	0	0.00
FB-4	225	2	10	1068.20	2	10	1068.20	0	0	0.00	200	2	10	1068.20	2	10	1068.20	0	0	0	0.00
Ce-1	395	2	25	560.00	1	25	560.00	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Ce-2	395	2	25	560.00	1	25	560.00	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Ce-3	395	2	25	560.00	1	25	560.00	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Ce-4	395	2	25	605.00	1	25	605.00	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
Ce-5	395	2	25	605.00	1	25	605.00	0	0	0.00	0	0	0	0.00	0	0	0.00	0	0	0	0.00
He-1	400	2	25.4	430	2	25.4	430	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00
He-2	400	2	25.4	430	2	25.4	430	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00
He-3	400	2	25.4	430	2	25.4	430	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00
He-4	400	2	25.4	430	2	25.4	430	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00
He-5	400	2	25.4	491	2	25.4	491	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00
He-6	400	2	25.4	491	2	25.4	491	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00
He7	400	2	25.4	491	2	25.4	491	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00
LK-1	400	2	22	455	2	22	455	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00
LK-2	400	2	22	473	2	22	473	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0.00

Table A3 — Database storage for concentric-exterior beam-column joints (22/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-2														
	4th layer				5th layer				6th layer						
	d_4	Outer+Inner bar			d_5	Outer+Inner bar			d_6	Outer Bars			Inner Bar		
	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	[mm]	n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$
H-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pa-1	0	0	0	0	0	0	0	0	60	2	20	296.00	0	0	0.00
Pa-2	0	0	0	0	0	0	0	0	60	2	24	300.00	2	24	300.00
Pa-3	0	0	0	0	0	0	0	0	60	2	20	296.00	0	0	0.00
Ka-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ka-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ka-3	0	0	0	0	0	0	0	0	60	2	12	318	1	12	318

Table A3 — Database storage for concentric- exterior beam-column joints (23/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-2														
	4th layer				5th layer				6th layer						
	d_4 [mm]	Outer+Inner bar			d_5 [mm]	Outer+Inner bar			d_6 [mm]	Outer Bars			Inner Bar		
		n	d_{bar} [mm]	$f_y [MPa]$		n	d_{bar} [mm]	$f_y [MPa]$		n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$
EW5-1	0	0	0	0	0	0	0	0	99.06	2	19.1	344.74	1	19.1	344.74
EW5-2	0	0	0	0	0	0	0	0	99.06	2	19.1	344.74	1	19.1	344.74
EW5-3	0	0	0	0	0	0	0	0	99.06	2	19.1	344.74	1	19.1	344.74
EW5-4	0	0	0	0	0	0	0	0	99.06	2	19.1	344.74	1	19.1	344.74
EW5-5	0	0	0	0	0	0	0	0	99.06	2	19.1	344.74	1	19.1	344.74
EW7-1	0	0	0	0	0	0	0	0	99.06	2	15.9	455.06	0	0	0.00
EW7-2	0	0	0	0	0	0	0	0	99.06	2	19.1	455.06	0	0	0.00
EW7-3	0	0	0	0	0	0	0	0	99.06	2	15.9	455.06	0	0	0.00
EW7-4	0	0	0	0	0	0	0	0	99.06	2	15.9	455.06	0	0	0.00
Al-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (24/51)

No. ID	Arrangement of Beam Longitudinal Reinforcement-2														
	4th layer				5th layer				6th layer						
	d_4 [mm]	Outer+Inner bar			d_5 [mm]	Outer+Inner bar			d_6 [mm]	Outer Bars			Inner Bar		
		n	d_{bar} [mm]	$f_y[MPa]$		n	d_{bar} [mm]	$f_y[MPa]$		n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$
FB-1	0	0	0	0	0	0	0	0	50	2	10	1068.20	2	10	1068.20
FB-2	0	0	0	0	0	0	0	0	50	2	10	408.66	2	10	408.66
FB-3	0	0	0	0	0	0	0	0	50	2	10	1068.20	2	10	1068.20
FB-4	0	0	0	0	0	0	0	0	50	2	10	1068.20	2	10	1068.20
Ce-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-1	0	0	0	0	0	0	0	0	50	2	10	1068.2	2	10	1068.2
He-2	0	0	0	0	0	0	0	0	50	2	10	408.66	2	10	408.66
He-3	0	0	0	0	0	0	0	0	50	2	10	1068.2	2	10	1068.2
He-4	0	0	0	0	0	0	0	0	50	2	10	1068.2	2	10	1068.2
He-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (25/51)

No. ID	Beam Longitudinal Reinforcement-3									
	7^{th} layer									
	d_7 [mm]	Corner bar			Intermediate Bar			Inner Bar		
		n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$	n	d_{bar} [mm]	$f_y[MPa]$
H-4	38.1	2	25.4	437.13	0	0	0	0	0	0
H-5	38.1	2	25.4	448.16	0	0	0	0	0	0
Ye-1	40	3	22	350	0	0	0	0	0	0
Ye-2	40	2	25	350	0	0	0	0	0	0
Ye-3	40	1	29	350	0	0	0	0	0	0
Ye-4	40	0	0	350	0	0	0	0	0	0
Ye-5	40	2	25	350	0	0	0	0	0	0
Ye-6	40	3	13	350	0	0	0	0	0	0
Ye-7	40	1	16	350	0	0	0	0	0	0
Ye-8	40	1	16	350	0	0	0	0	0	0
Ye-9	40	0	19	350	0	0	0	0	0	0
Ye-10	40	1	16	350	0	0	0	0	0	0
Pa-1	35	2	20	296.00	2	20	296.00	0	0	0
Pa-2	35	2	24	300.00	2	24	300.00	0	0	0
Pa-3	35	2	20	296.00	2	20	296.00	0	0	0
Ka-1	50	2	19	387.10	2	19	387.10	0	0	0
Ka-2	50	2	19	387.10	2	19	387.10	0	0	0
Ka-3	50	2	19	387.10	2	19	387.10	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (26/51)

No. ID	Beam Longitudinal Reinforcement-3									
	7th layer									
	d_7 [mm]	Corner bar			Intermediate Bar			Inner Bar		
		n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$
EW5-1	50.8	2	22.2	330.95	1	22.2	330.95	0	0	0
EW5-2	50.8	2	22.2	330.95	1	22.2	330.95	0	0	0
EW5-3	48.26	2	22.2	330.95	1	22.2	330.95	0	0	0
EW5-4	50.8	2	22.2	330.95	1	22.2	330.95	0	0	0
EW5-5	50.8	2	22.2	330.95	1	22.2	330.95	0	0	0
EW7-1	50.8	2	19.1	455.06	1	15.9	455.06	0	0	0
EW7-2	50.8	2	19.1	455.06	1	19.1	455.06	0	0	0
EW7-3	50.8	2	19.1	455.06	1	19.1	455.06	0	0	0
EW7-4	50.8	2	22.2	455.06	1	22.2	455.06	0	0	0
Al-1	73.025	2	25.4	456.99	2	25.4	456.99	0	0	0
Al-2	73.025	2	25.4	456.99	2	25.4	456.99	0	0	0
Al-3	76.2	2	28.7	442.85	2	28.7	442.85	0	0	0
Al-4	76.2	2	28.7	442.85	2	28.7	442.85	0	0	0
Al-5	63.5	2	25.4	456.99	2	25.4	456.99	0	0	0
Al-6	69.85	2	25.4	456.99	2	25.4	456.99	0	0	0
Al-7	66.675	2	28.7	442.85	2	28.7	442.85	0	0	0
Al-8	69.85	2	28.7	442.85	2	28.7	442.85	0	0	0
Al-9	73.025	2	25.4	456.99	2	25.4	456.99	0	0	0
Al-10	73.025	2	25.4	456.99	2	25.4	456.99	0	0	0
Al-11	79.375	2	28.7	442.85	2	28.7	442.85	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (27/51)

No. ID	Beam Longitudinal Reinforcement-3									
	7th layer									
	d_7 [mm]	Corner bar			Intermediate Bar			Inner Bar		
		n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$	n	d_{bar} [mm]	$f_y [MPa]$
FB-1	25	2	10	1068.20	2	10	1068.20	0	0	0
FB-2	25	2	10	408.66	2	10	408.66	0	0	0
FB-3	25	2	10	1068.20	2	10	1068.20	0	0	0
FB-4	25	2	10	1068.20	2	10	1068.20	0	0	0
Ce-1	55	2	25	560.00	1	25	560.00	0	0	0
Ce-2	55	2	25	560.00	1	25	560.00	0	0	0
Ce-3	55	2	25	560.00	1	25	560.00	0	0	0
Ce-4	55	2	25	605.00	1	25	605.00	0	0	0
Ce-5	55	2	25	605.00	1	25	605.00	0	0	0
He-1	50	2	25.4	430.00	2	25.4	430.00	0	0	0
He-2	50	2	25.4	430.00	2	25.4	430.00	0	0	0
He-3	50	2	25.4	430.00	2	25.4	430.00	0	0	0
He-4	50	2	25.4	430.00	2	25.4	430.00	0	0	0
He-5	50	2	25.4	491.00	2	25.4	491.00	0	0	0
He-6	50	2	25.4	491.00	2	25.4	491.00	0	0	0
He7	50	2	25.4	491.00	2	25.4	491.00	0	0	0
LK-1	50	2	22	455.00	2	22	455.00	0	0	0
LK-2	50	2	22	473.00	2	22	473.00	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (28/51)

No. ID	Beam Transverse Reinf.													
	Section-1							Section-2						
	Length [mm]	s_{hz_1} [mm]	f_y [MPa]	Stirrup		Vert. Ties		Length [mm]	s_{hz_2} [mm]	f_y [MPa]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
H-4	whole	114.3	506.77	2	9.53	0	0	0	0	0	0	0	0	0
H-5	whole	114.3	506.77	2	9.53	0	0	0	0	0	0	0	0	0
Ye-1	whole	100	240	2	12.7	0	0	0	0	0	0	0	0	0
Ye-2	whole	100	240	2	12.7	0	0	0	0	0	0	0	0	0
Ye-3	whole	100	240	2	12.7	0	0	0	0	0	0	0	0	0
Ye-4	whole	100	240	2	12.7	0	0	0	0	0	0	0	0	0
Ye-5	whole	100	240	2	12.7	0	0	0	0	0	0	0	0	0
Ye-6	whole	60	300	2	6	0	0	0	0	0	0	0	0	0
Ye-7	whole	60	300	2	6	0	0	0	0	0	0	0	0	0
Ye-8	whole	60	300	2	6	0	0	0	0	0	0	0	0	0
Ye-9	whole	60	300	2	6	0	0	0	0	0	0	0	0	0
Ye-10	whole	60	300	2	6	0	0	0	0	0	0	0	0	0
Pa-1	1329	100	316	2	10	2	10	1100	120	316	2	10	2	10
Pa-2	1329	100	316	2	10	2	10	1100	120	316	2	10	2	10
Pa-3	1329	100	316	2	10	2	10	1100	120	316	2	10	2	10
Ka-1	whole	50	294	2	9	0	0	0	0	0	0	0	0	0
Ka-2	whole	50	294	2	9	0	0	0	0	0	0	0	0	0
Ka-3	whole	50	294	2	9	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (29/51)

No. ID	Beam Transverse Reinf.													
	Section-1							Section-2						
	Length [mm]	s_{hz_1} [mm]	f_y [MPa]	Stirrup		Vert. Ties		Length [mm]	s_{hz_2} [mm]	f_y [MPa]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
EW5-1	whole	?	437.13	2	12.7	0	0	0	0	0	0	0	0	0
EW5-2	whole	?	437.13	2	12.7	0	0	0	0	0	0	0	0	0
EW5-3	whole	?	437.13	2	12.7	0	0	0	0	0	0	0	0	0
EW5-4	whole	?	437.13	2	12.7	0	0	0	0	0	0	0	0	0
EW5-5	whole	?	437.13	2	12.7	0	0	0	0	0	0	0	0	0
EW7-1	whole	?	455.06	2	12.7	0	0	0	0	0	0	0	0	0
EW7-2	whole	?	455.06	2	12.7	0	0	0	0	0	0	0	0	0
EW7-3	whole	?	455.06	2	12.7	0	0	0	0	0	0	0	0	0
EW7-4	whole	?	455.06	2	12.7	0	0	0	0	0	0	0	0	0
Al-1	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-2	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-3	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-4	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-5	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-6	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-7	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-8	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-9	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-10	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0
Al-11	whole	76.2	446.44	2	12.7	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (30/51)

No. ID	Beam Transverse Reinf.													
	Section-1							Section-2						
	Length [mm]	s_{hz_1} [mm]	f_y [MPa]	Stirrup		Vert. Ties		Length [mm]	s_{hz_2} [mm]	f_y [MPa]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
FB-1	whole	?	291.06	2	6	0	0	0	0	0	0	0	0	0
FB-2	whole	?	291.06	2	6	0	0	0	0	0	0	0	0	0
FB-3	whole	?	291.06	2	6	0	0	0	0	0	0	0	0	0
FB-4	whole	?	291.06	2	6	0	0	0	0	0	0	0	0	0
Ce-1	whole	60	369	2	10	0	0	0	0	0	0	0	0	0
Ce-2	whole	60	369	2	10	0	0	0	0	0	0	0	0	0
Ce-3	whole	60	369	2	10	0	0	0	0	0	0	0	0	0
Ce-4	whole	60	369	2	10	0	0	0	0	0	0	0	0	0
Ce-5	whole	60	369	2	10	0	0	0	0	0	0	0	0	0
He-1	whole	90	498	2	12.7	0	0	0	0	0	0	0	0	0
He-2	whole	90	498	2	12.7	0	0	0	0	0	0	0	0	0
He-3	whole	90	498	2	12.7	0	0	0	0	0	0	0	0	0
He-4	whole	90	498	2	12.7	0	0	0	0	0	0	0	0	0
He-5	whole	90	498	2	12.7	0	0	0	0	0	0	0	0	0
He-6	whole	90	498	2	12.7	0	0	0	0	0	0	0	0	0
He7	whole	90	498	2	12.7	0	0	0	0	0	0	0	0	0
LK-1	whole	100	471	2	10	2	10	0	0	0	0	0	0	0
LK-2	whole	100	471	2	10	2	10	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (31/51)

No. ID	Joint Dimension				Joint Transverse Reinforcement - 1								
	b_{jt}[mm]	h_{jt}[mm]	d_{jt}[mm]	f_c'[MPa]	Type of Hz. Reinf.	No. of joint set	$s_{\mathrm{vert.}}$	Outer hoop			Ties in X-dir		
								n-set	d_{bar}	f_y[MPa]	n-set	d_{bar}	f_y[MPa]
H-4	381	381	431.8	37.09	1	3	76.2	12.7	1	460.57	0	0	0.00
H-5	381	381	431.8	36.13	1	3	76.2	12.7	1	461.95	0	0	0.00
Ye-1	500	500	470	25.68	1	4	140	1	12.7	240	0	0	0.00
Ye-2	500	500	470	21.95	1	4	140	1	12.7	240	0	0	0.00
Ye-3	500	500	470	22.15	1	4	140	1	12.7	240	0	0	0.00
Ye-4	500	500	470	23.03	1	4	140	1	12.7	240	0	0	0.00
Ye-5	500	500	470	23.13	1	4	140	1	12.7	240	0	0	0.00
Ye-6	270	270	220	22.93	1	4	140	1	6	300	0	0	0.00
Ye-7	270	270	220	21.85	1	4	140	1	6	300	0	0	0.00
Ye-8	270	270	220	23.42	1	4	140	1	6	300	0	0	0.00
Ye-9	270	270	220	21.95	1	4	140	1	6	300	0	0	0.00
Ye-10	270	270	220	22.54	1	4	140	1	6	300	0	0	0.00
Pa-1	457	457	540	22.60	2	4	110	1	12	326.00	2	12	326.00
Pa-2	457	457	540	22.50	2	4	110	1	10	316.00	2	10	316.00
Pa-3	457	457	540	26.90	2	3	110	1	10	316.00	2	10	316.00
Ka-1	300	300	283	24.30	1	0	0	0	0	0.00	0	0	0.00
Ka-2	300	300	284	26.66	1	3	100	1	9	300.00	0	0	300.00
Ka-3	300	300	285	30.09	1	3	50	1	9	300.00	0	0	300.00

Table A3 — Database storage for concentric- exterior beam-column joints (32/51)

No. ID	Joint Dimension				Joint Transverse Reinforcement - 1								
	b_{jt}[mm]	h_{jt}[mm]	d_{jt}[mm]	f_c'[MPa]	Type of Hz. Reinf.	No. of joint set	$s_{vert.}$	Outer hoop			Ties in X-dir		
								n-set	d_{bar}	f_y[MPa]	n-set	d_{bar}	f_y[MPa]
EW5-1	299.72	299.72	378.46	33.58	6	2	150	1	12.7	437.13	0	0	437.13
EW5-2	299.72	299.72	378.46	40.89	6	3	126.13	1	12.7	437.13	0	0	437.13
EW5-3	299.72	299.72	342.9	44.61	7	3	126.13	1	12.7	437.13	0	0	437.13
EW5-4	340.36	340.36	378.46	24.34	7	2	150	1	12.7	437.13	0	0	437.13
EW5-5	340.36	340.36	378.46	39.78	6	2	150	1	12.7	437.13	0	0	437.13
EW7-1	340.36	340.36	378.46	64.67	6	3	93.98	1	12.7	455.06	0	0	455.06
EW7-2	340.36	340.36	378.46	67.29	6	3	93.98	1	12.7	455.06	0	0	455.06
EW7-3	299.72	299.72	337.82	64.67	6	3	93.98	1	12.7	455.06	0	0	455.06
EW7-4	299.72	299.72	337.82	67.29	6	3	93.98	1	12.7	455.06	0	0	455.06
Al-1	355.6	355.6	361.95	56.54	3	4	63.5	1	12.7	446.44	0	0	0
Al-2	355.6	355.6	361.95	56.54	3	6	63.5	1	12.7	446.44	0	0	0
Al-3	355.6	355.6	355.6	56.54	3	4	63.5	1	12.7	446.44	0	0	0
Al-4	355.6	355.6	355.6	56.54	3	6	63.5	1	12.7	446.44	0	0	0
Al-5	355.6	355.6	381	74.46	3	4	63.5	1	12.7	446.44	0	0	0
Al-6	355.6	355.6	368.3	74.46	3	6	63.5	1	12.7	446.44	0	0	0
Al-7	355.6	355.6	374.65	74.46	3	4	63.5	1	12.7	446.44	0	0	0
Al-8	355.6	355.6	368.3	74.46	3	6	63.5	1	12.7	446.44	0	0	0
Al-9	355.6	355.6	361.95	96.53	3	4	63.5	1	12.7	446.44	0	0	0
Al-10	355.6	355.6	361.95	96.53	3	6	63.5	1	12.7	446.44	0	0	0
Al-11	355.6	355.6	349.25	96.53	3	6	63.5	1	12.7	446.44	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (33/51)

No. ID	Joint Dimension				Joint Transverse Reinforcement - 1								
	b_{jt}[mm]	h_{jt}[mm]	d_{jt}[mm]	f_c'[MPa]	Type of Hz. Reinf.	No. of joint set	$s_{\mathrm{vert.}}$	Outer hoop			Ties in X-dir		
								n-set	d_{bar}	f_y[MPa]	n-set	d_{bar}	f_y[MPa]
FB-1	220	220	200	29.99	1	3	62.6	1	6	291.00	0	0	291.00
FB-2	220	220	200	29.99	1	3	62.6	1	6	291.00	0	0	291.00
FB-3	220	220	200	29.99	1	3	62.6	1	6	291.00	0	0	291.00
FB-4	220	220	200	29.99	5	4	46.7	2	6	291.00	0	0	291.00
Ce-1	400	400	340	50.00	4	3	112.5	1	10	369.00	2	10	369.00
Ce-2	400	400	340	70.00	4	3	112.5	1	10	369.00	2	10	369.00
Ce-3	400	400	340	21.00	4	3	112.5	1	10	369.00	2	10	369.00
Ce-4	400	400	340	50.00	4	3	112.5	1	10	369.00	2	10	369.00
Ce-5	400	400	340	50.00	4	3	112.5	1	10	369.00	2	10	369.00
He-1	420	420	350	76.80	3	3	97	2	12.7	498.00	2	12.7	498
He-2	420	420	350	69.00	3	3	97	1	9.53	471.00	1	9.53	471
He-3	420	420	350	71.00	1	2	146	1	12.7	498.00	0	0	0
He-4	420	420	350	72.80	1	1	293	2	12.7	498.00	0	0	0
He-5	450	450	350	75.20	3	3	97	1	12.7	436.00	1	12.7	436
He-6	450	450	350	76.60	1	2	146	1	15.9	469.00	0	0	0
He7	450	450	350	69.70	1	1	293	2	15.9	469.00	0	0	0
LK-1	400	600	350	28.50	3	3	160	1	15.9	469.00	1	10	471
LK-2	600	400	350	29.50	3	3	160	1	15.9	469.00	3	10	471

Table A3 — Database storage for concentric-exterior beam-column joints (34/51)

No. ID	Joint Transverse Reinforcement -2						Provided Reinf		Code req		$\frac{A_{sh\_prov}}{A_{sh\_req}}$
	Ties in Y Direction			Diagonal Ties			Ash-x [%]	Ash-y [%]	Ash-x [%]	Ash-y [%]	
	n-set	d_{bar} [mm]	f_y[MPa]	n-set	d_{bar}[mm]	f_y[MPa]					
H-4	0	0	0	0	0	0	0.0101	0.0101	0.0080	0.0080	1.26
H-5	0	0	0	0	0	0	0.0101	0.0101	0.0078	0.0078	1.29
Ye-1	0	0	0	0	0	0	0.0038	0.0038	0.0096	0.0096	0.40
Ye-2	0	0	0	0	0	0	0.0038	0.0038	0.0082	0.0082	0.47
Ye-3	0	0	0	0	0	0	0.0038	0.0038	0.0083	0.0083	0.46
Ye-4	0	0	0	0	0	0	0.0038	0.0038	0.0086	0.0086	0.44
Ye-5	0	0	0	0	0	0	0.0038	0.0038	0.0087	0.0087	0.44
Ye-6	0	0	0	0	0	0	0.0019	0.0019	0.0122	0.0122	0.15
Ye-7	0	0	0	0	0	0	0.0019	0.0019	0.0117	0.0117	0.16
Ye-8	0	0	0	0	0	0	0.0019	0.0019	0.0125	0.0125	0.15
Ye-9	0	0	0	0	0	0	0.0019	0.0019	0.0117	0.0117	0.16
Ye-10	0	0	0	0	0	0	0.0019	0.0019	0.0120	0.0120	0.15
Pa-1	2	12	326	0	0	0	0.0095	0.0095	0.0062	0.0062	1.53
Pa-2	2	10	316	0	0	0	0.0067	0.0067	0.0064	0.0064	1.04
Pa-3	2	10	316	0	0	0	0.0067	0.0067	0.0077	0.0077	0.87
Ka-1	0	0	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.00
Ka-2	0	0	0	0	0	0	0.0045	0.0045	0.0080	0.0080	0.57
Ka-3	0	0	0	0	0	0	0.0091	0.0091	0.0090	0.0090	1.01

Table A3 — Database storage for concentric- exterior beam-column joints (35/51)

No. ID	Joint Transverse Reinforcement -2						Provided Reinf		Code req		$\frac{A_{sh\_prov}}{A_{sh\_req}}$
	Ties in Y Direction			Diagonal Ties			Ash-x [%]	Ash-y [%]	Ash-x [%]	Ash-y [%]	
	n-set	d_{bar} [mm]	f_y[MPa]	n-set	d_{bar}[mm]	f_y[MPa]					
EW5-1	0	0	0	1	12.7	437.13	0.0119	0.0119	0.0121	0.0121	0.87
EW5-2	0	0	0	1	12.7	437.13	0.0141	0.0141	0.0148	0.0148	1.30
EW5-3	0	0	0	1	12.7	437.13	0.0141	0.0141	0.0161	0.0161	1.48
EW5-4	0	0	0	1	12.7	437.13	0.0100	0.0100	0.0064	0.0064	0.78
EW5-5	0	0	0	1	12.7	437.13	0.0102	0.0102	0.0121	0.0121	0.74
EW7-1	0	0	0	1	12.7	455.06	0.0161	0.0161	0.0176	0.0176	0.91
EW7-2	0	0	0	1	12.7	455.06	0.0161	0.0161	0.0183	0.0183	0.88
EW7-3	0	0	0	1	12.7	455.06	0.0187	0.0187	0.0208	0.0208	0.90
EW7-4	0	0	0	1	12.7	455.06	0.0185	0.0185	0.0200	0.0200	0.93
Al-1	0	0	0	0	0	0	0.0214	0.0143	0.0235	0.0235	0.91
Al-2	0	0	0	0	0	0	0.0214	0.0143	0.0235	0.0235	0.91
Al-3	0	0	0	0	0	0	0.0214	0.0143	0.0235	0.0235	0.91
Al-4	0	0	0	0	0	0	0.0214	0.0143	0.0235	0.0235	0.91
Al-5	0	0	0	0	0	0	0.0214	0.0143	0.0310	0.0310	0.69
Al-6	0	0	0	0	0	0	0.0214	0.0143	0.0310	0.0310	0.69
Al-7	0	0	0	0	0	0	0.0214	0.0143	0.0310	0.0310	0.69
Al-8	0	0	0	0	0	0	0.0214	0.0143	0.0310	0.0310	0.69
Al-9	0	0	0	0	0	0	0.0214	0.0143	0.0402	0.0402	0.53
Al-10	0	0	0	0	0	0	0.0214	0.0143	0.0402	0.0402	0.53
Al-11	0	0	0	0	0	0	0.0214	0.0143	0.0402	0.0402	0.53

Table A3 — Database storage for concentric- exterior beam-column joints (36/51)

No. ID	Joint Transverse Reinforcement -2						Provided Reinf		Code req		$\frac{A_{sh\_prov}}{A_{sh\_req}}$
	Ties in Y Direction			Diagonal Ties			Ash-x [%]	Ash-y [%]	Ash-x [%]	Ash-y [%]	
	n-set	d_{bar} [mm]	f_y[MPa]	n-set	d_{bar}[mm]	f_y[MPa]					
FB-1	0	0	0	0	0	0	0.0041	0.0049	0.0129	0.0129	0.32
FB-2	0	0	0	0	0	0	0.0049	0.0049	0.0129	0.0129	0.38
FB-3	0	0	0	0	0	0	0.0049	0.0049	0.0129	0.0129	0.38
FB-4	0	0	0	0	0	0	0.0131	0.0131	0.0129	0.0129	1.01
Ce-1	0	0	0	0	0	0	0.0079	0.0040	0.0122	0.0122	0.65
Ce-2	0	0	0	0	0	0	0.0079	0.0040	0.0171	0.0171	0.46
Ce-3	0	0	0	0	0	0	0.0079	0.0040	0.0051	0.0051	1.55
Ce-4	0	0	0	0	0	0	0.0079	0.0040	0.0122	0.0122	0.65
Ce-5	0	0	0	0	0	0	0.0079	0.0040	0.0122	0.0122	0.65
He-1	2	12.7	498	0	0	0	0.0230	0.0230	0.0243	0.0243	0.95
He-2	1	12.7	471	0	0	0	0.0065	0.0082	0.0231	0.0231	0.28
He-3	0	0	0	0	0	0	0.0051	0.0051	0.0225	0.0225	0.23
He-4	0	0	0	0	0	0	0.0051	0.0051	0.0231	0.0231	0.22
He-5	1	12.7	436	0	0	0	0.0106	0.0106	0.0248	0.0248	0.43
He-6	0	0	0	0	0	0	0.0073	0.0073	0.0235	0.0235	0.31
He7	0	0	0	0	0	0	0.0073	0.0073	0.0214	0.0214	0.34
LK-1	3	10	471	0	0	0	0.0084	0.0071	0.0055	0.0055	1.54
LK-2	1	10	471	0	0	0	0.0071	0.0084	0.0057	0.0057	1.26

Table A3 — Database storage for concentric- exterior beam-column joints (37/51)

No. ID	TB horizontal relative position to main beam	TB vertical relative position to main beam	Transverse Beam Dimension							
			North Beam		South Beam		b_{tb} [mm]	h_{tb} [mm]	Cover-x[mm]	Cover-y[mm]
			f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
H-4	0	0	0	0	0	0	0	0	0	0
H-5	0	0	0	0	0	0	0	0	0	0
Ye-1	0	0	27.23	730	27.23	730	350	550	40	40
Ye-2	0	0	27.23	730	27.23	730	350	550	40	40
Ye-3	0	0	27.23	730	27.23	730	350	550	40	40
Ye-4	0	0	27.23	730	27.23	730	350	550	40	40
Ye-5	0	0	27.23	730	27.23	730	350	550	40	40
Ye-6	0	0	27.23	325	27.23	325	190	300	40	40
Ye-7	0	0	27.23	325	27.23	325	190	300	40	40
Ye-8	0	0	27.23	325	27.23	325	190	300	40	40
Ye-9	0	0	27.23	325	27.23	325	190	300	40	40
Ye-10	0	0	27.23	325	27.23	325	190	300	40	40
Pa-1	0	0	0	0	0	0	0	0	0	0
Pa-2	0	0	0	0	0	0	0	0	0	0
Pa-3	0	0	0	0	0	0	0	0	0	0
Ka-1	0	0	0	0	0	0	0	0	0	0
Ka-2	0	0	0	0	0	0	0	0	0	0
Ka-3	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (38/51)

No. ID	TB horizontal relative position to main beam	TB vertical relative position to main beam	Transverse Beam Dimension							
			North Beam		South Beam		b_{tb}[mm]	h_{tb}[mm]	Cover-x[mm]	Cover-y[mm]
			f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
EW5-1	0	0	0	0	0	0	0	0	0	0
EW5-2	0	0	0	0	0	0	0	0	0	0
EW5-3	0	0	0	0	0	0	0	0	0	0
EW5-4	0	0	0	0	0	0	0	0	0	0
EW5-5	0	0	0	0	0	0	0	0	0	0
EW7-1	0	0	0	0	0	0	0	0	0	0
EW7-2	0	0	0	0	0	0	0	0	0	0
EW7-3	0	0	0	0	0	0	0	0	0	0
EW7-4	0	0	0	0	0	0	0	0	0	0
Al-1	0	0	0	0	0	0	0	0	0	0
Al-2	0	0	0	0	0	0	0	0	0	0
Al-3	0	0	0	0	0	0	0	0	0	0
Al-4	0	0	0	0	0	0	0	0	0	0
Al-5	0	0	0	0	0	0	0	0	0	0
Al-6	0	0	0	0	0	0	0	0	0	0
Al-7	0	0	0	0	0	0	0	0	0	0
Al-8	0	0	0	0	0	0	0	0	0	0
Al-9	0	0	0	0	0	0	0	0	0	0
Al-10	0	0	0	0	0	0	0	0	0	0
Al-11	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (39/51)

No. ID	TB horizontal relative position to main beam	TB vertical relative position to main beam	Transverse Beam Dimension							
			North Beam		South Beam		b_{tb}[mm]	h_{tb}[mm]	Cover-x[mm]	Cover-y[mm]
			f_c'[MPa]	Length [mm]	f_c'[MPa]	Length [mm]				
FB-1	0	0	0	0	0	0	0	0	0	0
FB-2	0	0	0	0	0	0	0	0	0	0
FB-3	0	0	0	0	0	0	0	0	0	0
FB-4	0	0	0	0	0	0	0	0	0	0
Ce-1	0	0	0	0	0	0	0	0	0	0
Ce-2	0	0	0	0	0	0	0	0	0	0
Ce-3	0	0	0	0	0	0	0	0	0	0
Ce-4	0	0	0	0	0	0	0	0	0	0
Ce-5	0	0	0	0	0	0	0	0	0	0
He-1	0	0	0	0	0	0	0	0	0	0
He-2	0	0	0	0	0	0	0	0	0	0
He-3	0	0	0	0	0	0	0	0	0	0
He-4	0	0	0	0	0	0	0	0	0	0
He-5	0	0	0	0	0	0	0	0	0	0
He-6	0	0	0	0	0	0	0	0	0	0
He7	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (40/51)

No. ID	Arrangement of Transverse Beam Longitudinal Reinforcement-1																	
	1st layer							2nd layer				3rd layer						
	d_1	Outer bar			Inner Bar			Side Bar				d_3	Outer Bar			Inner Bar		
	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar}	f_y $[MPa]$	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
H-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-1	510	2	25.4	350	2	25.4	350	0	0	0	0	40	2	25.4	350	2	25.4	350
Ye-2	510	2	25.4	350	2	25.4	350	0	0	0	0	40	2	25.4	350	2	25.4	350
Ye-3	510	2	25.4	350	2	25.4	350	0	0	0	0	40	2	25.4	350	2	25.4	350
Ye-4	510	2	25.4	350	2	25.4	350	0	0	0	0	40	2	25.4	350	2	25.4	350
Ye-5	510	2	25.4	350	2	25.4	350	0	0	0	0	40	2	25.4	350	2	25.4	350
Ye-6	260	2	16	350	1	16	350	0	0	0	0	40	2	16	350	1	16	350
Ye-7	260	2	16	350	1	16	350	0	0	0	0	40	2	16	350	1	16	350
Ye-8	260	2	16	350	1	16	350	0	0	0	0	40	2	16	350	1	16	350
Ye-9	260	2	16	350	1	16	350	0	0	0	0	40	2	16	350	1	16	350
Ye-10	260	2	16	350	1	16	350	0	0	0	0	40	2	16	350	1	16	350
Pa-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pa-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pa-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ka-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ka-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ka-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (41/51)

No. ID	Arrangement of Transverse Beam Longitudinal Reinforcement-1																	
	1st layer							2nd layer				3rd layer						
	d_1 [mm]	Outer bar			Inner Bar			Side Bar				d_3 [mm]	Outer Bar			Inner Bar		
		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar}	f_y $[MPa]$		n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
EW5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric- exterior beam-column joints (42/51)

No. ID	Arrangement of Transverse Beam Longitudinal Reinforcement-1																	
	1st layer							2nd layer				3rd layer						
	d_1	Outer bar			Inner Bar			Side Bar				d_3	Outer Bar			Inner Bar		
	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$	d_2 [mm]	n	d_{bar}	f_y $[MPa]$	[mm]	n	d_{bar} [mm]	f_y $[MPa]$	n	d_{bar} [mm]	f_y $[MPa]$
FB-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-interior beam-column joints (43/51)

No. ID	Beam Transverse Reinf.						
	Whole Section						
	Length [mm]	f_y $[MPa]$	s_{hz}[mm]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
H-4	0	0	0	0	0	0	0
H-5	0	0	0	0	0	0	0
Ye-1	whole	240	100	2	12.7	0	0
Ye-2	whole	240	100	2	12.7	0	0
Ye-3	whole	240	100	2	12.7	0	0
Ye-4	whole	240	100	2	12.7	0	0
Ye-5	whole	240	100	2	12.7	0	0
Ye-6	whole	300	60	2	6	0	0
Ye-7	whole	300	60	2	6	0	0
Ye-8	whole	300	60	2	6	0	0
Ye-9	whole	300	60	2	6	0	0
Ye-10	whole	300	60	2	6	0	0
Pa-1	0	0	0	0	0	0	0
Pa-2	0	0	0	0	0	0	0
Pa-3	0	0	0	0	0	0	0
Ka-1	0	0	0	0	0	0	0
Ka-2	0	0	0	0	0	0	0
Ka-3	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-interior beam-column joints (44/51)

No. ID	Beam Transverse Reinf.						
	Whole Section						
	Length [mm]	f_y [MPa]	s_{hz}[mm]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
EW5-1	0	0	0	0	0	0	0
EW5-2	0	0	0	0	0	0	0
EW5-3	0	0	0	0	0	0	0
EW5-4	0	0	0	0	0	0	0
EW5-5	0	0	0	0	0	0	0
EW7-1	0	0	0	0	0	0	0
EW7-2	0	0	0	0	0	0	0
EW7-3	0	0	0	0	0	0	0
EW7-4	0	0	0	0	0	0	0
Al-1	0	0	0	0	0	0	0
Al-2	0	0	0	0	0	0	0
Al-3	0	0	0	0	0	0	0
Al-4	0	0	0	0	0	0	0
Al-5	0	0	0	0	0	0	0
Al-6	0	0	0	0	0	0	0
Al-7	0	0	0	0	0	0	0
Al-8	0	0	0	0	0	0	0
Al-9	0	0	0	0	0	0	0
Al-10	0	0	0	0	0	0	0
Al-11	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-interior beam-column joints (45/51)

No. ID	Beam Transverse Reinf.						
	Whole Section						
	Length [mm]	f_y [MPa]	s_{hz}[mm]	Stirrup		Vert. Ties	
				n-leg	d_{bar} [mm]	n-leg	d_{bar} [mm]
FB-1	0	0	0	0	0	0	0
FB-2	0	0	0	0	0	0	0
FB-3	0	0	0	0	0	0	0
FB-4	0	0	0	0	0	0	0
Ce-1	0	0	0	0	0	0	0
Ce-2	0	0	0	0	0	0	0
Ce-3	0	0	0	0	0	0	0
Ce-4	0	0	0	0	0	0	0
Ce-5	0	0	0	0	0	0	0
He-1	0	0	0	0	0	0	0
He-2	0	0	0	0	0	0	0
He-3	0	0	0	0	0	0	0
He-4	0	0	0	0	0	0	0
He-5	0	0	0	0	0	0	0
He-6	0	0	0	0	0	0	0
He7	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (46/51)

No.ID	Dimension						Reinforcement							
	thickness	f’c	Along loading-dir		Perpendicular to loading dir		Along loading-direction				Perpendicular to loading-direction			
			L_{slab_left} [mm]	L_{slab_right} [mm]	L_{slab_north} [mm]	L_{slab_south} [mm]	Top Reinf		Bot Reinf.		Top Reinf		Bot Reinf.	
							d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]
H-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ye-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pa-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pa-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pa-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ka-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ka-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ka-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (47/51)

No.ID	Dimension						Reinforcement							
	thickness	f’c	Along loading-dir		Perpendicular to loading dir		Along loading-direction				Perpendicular to loading-direction			
			L_{slab_left} [mm]	L_{slab_right} [mm]	L_{slab_north} [mm]	L_{slab_south} [mm]	Top Reinf		Bot Reinf.		Top Reinf		Bot Reinf.	
							d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]
EW5-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW5-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW7-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Al-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (48/51)

No.ID	Dimension						Reinforcement							
	thickness	f’c	Along loading-dir		Perpendicular to loading dir		Along loading-direction				Perpendicular to loading-direction			
			L_{slab_left} [mm]	L_{slab_right} [mm]	L_{slab_north} [mm]	L_{slab_south} [mm]	Top Reinf		Bot Reinf.		Top Reinf		Bot Reinf.	
							d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]	d_{bar} [mm]	s [mm]
FB-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FB-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ce-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
He7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LK-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A3 — Database storage for concentric-exterior beam-column joints (49/51)

No. ID	Failure Mode	Column axial load [%Agf’c]	Maximum Loading				Loading Curve								
			Positive		Negative		Type of Loading	Positive Loading				Negative Loading			
			P_{max}[kN]	Drift[%]	P_{max}[kN]	Drift[%]		$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$	$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$
H-4	J	50.43	139.00	1.30	80.00	2.00	III	130.00	138.00	120.00	-	76.00	77.00	79.60	-
H-5	J	28.97	225.00	1.50	90.80	1.10	III	128.00	138.00	146.00	-	79.70	87.70	78.10	-
Ye-1	BF	0	262.00	2.45	260.00	2.90	III	185.00	235.00	249.00	255.00	205.00	226.00	240.00	243.00
Ye-2	BF	0	309.00	4.30	243.00	3.30	III	208.00	284.00	283.00	306.00	127.00	208.00	222.00	233.00
Ye-3	BF	0	267.00	4.90	264.00	4.90	III	178.00	224.00	249.00	242.00	160.00	241.00	244.00	252.00
Ye-4	BF	0	270.00	3.00	247.00	5.00	III	139.00	247.00	255.00	261.00	148.00	211.00	225.00	251.00
Ye-5	BF	0	261.00	2.50	262.00	1.70	III	157.00	251.00	259.00	191.00	165.00	252.00	261.00	244.00
Ye-6	BF	0	79.00	5.50	82.10	5.00	III	48.60	74.20	78.30	78.70	54.00	72.00	77.60	81.10
Ye-7	BF	0	83.20	4.80	81.20	4.50	III	51.00	70.70	75.00	79.70	57.00	70.00	72.50	78.50
Ye-8	BF	0	87.00	6.80	81.00	4.60	III	44.00	67.20	72.70	79.10	52.00	67.20	74.20	78.30
Ye-9	BF	0	78.10	5.10	78.00	5.30	III	52.00	67.70	75.70	77.20	49.00	64.20	68.30	73.70
Ye-10	BF	0	83.00	5.50	71.40	1.90	III	48.00	55.60	74.10	78.30	63.10	67.00	76.00	64.10
Pa-1	BJ	5.30	160.00	3.29	152.00	13.11	III	130.00	141.00	153.00	-	114.00	127.00	141.00	-
Pa-2	BJ	15.00	222.00	3.79	218.00	14.75	III	183.00	197.00	211.00	-	164.00	177.00	196.00	-
Pa-3	BF	5.30	172.00	3.58	158.00	14.43	III	131.00	145.00	163.00	-	120.00	131.00	143.00	-
Ka-1	J	0.00	140.00	2.00	130.00	2.00	III	8.00	12.40	13.10	9.20	9.60	10.70	10.60	6.50
Ka-2	BJ	0.00	180.00	1.67	170.00	1.67	III	9.70	15.10	17.50	14.00	14.00	16.00	15.00	11.00
Ka-3	BJ	0.00	180.00	1.11	170.00	1.33	III	11.90	10.70	16.80	12.80	12.10	15.60	16.80	12.60

Table A3 — Database storage for concentric-exterior beam-column joints (50/51)

No. ID	Failure Mode	Column axial load [%Agf’c]	Maximum Loading				Loading Curve								
			Positive		Negative		Type of Loading	Positive Loading				Negative Loading			
			P_{max}[kN]	Drift[%]	P_{max}[kN]	Drift[%]		$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$	$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$
EW5-1	J	5.89	149.00	1.67	133.50	1.67	III	68.70	117.00	148.00	121.00	71.20	97.40	129.00	108.00
EW5-2	BJ	6.04	183.00	3.03	173.55	2.88	III	60.00	107.00	168.00	173.00	100.00	126.00	152.00	160.00
EW5-3	BJ	5.53	175.00	4.55	164.65	3.95	III	83.00	112.00	155.00	165.00	66.50	116.00	146.00	156.00
EW5-4	J	12.63	154.00	5.38	164.65	4.82	III	42.00	68.50	103.00	153.00	57.00	87.00	108.00	163.00
EW5-5	BJ	6.59	161.00	8.50	142.40	7.65	III	41.00	57.00	102.00	138.00	45.00	80.00	107.00	132.00
EW7-1	BF	2.14	133.50	5.68	155.75	5.68	III	78.00	106.00	117.00	139.00	62.20	115.00	136.00	155.00
EW7-2	BJ	4.34	182.45	5.68	186.90	4.95	III	87.50	123.00	152.00	181.00	70.00	137.00	161.00	178.00
EW7-3	BJ	6.58	137.95	5.74	129.05	4.27	III	42.00	86.40	112.00	131.00	62.00	92.20	113.00	120.00
EW7-4	BJ	5.37	204.70	4.57	151.30	2.80	III	48.00	85.70	138.00	162.00	70.50	100.00	145.00	151.00
Al-1	BJ	4.11	249.20	4.00	235.85	4.14	III	72.10	116.00	190.00	244.00	40.30	91.50	173.00	235.00
Al-2	BJ	4.11	231.40	4.00	235.85	4.71	III	62.50	107.00	178.00	237.00	62.80	103.00	184.00	230.00
Al-3	J	7.09	222.50	3.43	270.00	4.14	III	64.50	126.00	212.00	212.00	71.20	118.00	200.00	268.00
Al-4	BJ	7.09	265.00	4.29	262.55	3.57	III	63.50	106.00	193.00	262.00	50.00	97.00	188.00	258.00
Al-5	BJ	6.66	200.25	4.14	218.05	4.14	III	60.00	93.00	153.00	198.00	46.40	83.00	150.00	210.00
Al-6	BJ	6.66	271.45	4.57	280.35	5.43	III	58.00	101.00	171.00	264.00	61.50	117.00	187.00	277.00
Al-7	J	6.66	231.40	3.29	262.55	4.00	III	74.70	124.00	194.00	194.00	37.70	99.00	198.00	258.00
Al-8	BJ	6.66	281.40	4.14	267.00	4.14	III	62.10	117.00	196.00	281.00	66.50	112.00	193.00	260.00
Al-9	BJ	5.14	260.00	4.29	262.55	4.14	III	71.70	111.00	183.00	259.00	39.80	82.50	180.00	256.00
Al-10	BJ	5.14	267.00	4.00	264.00	4.14	III	40.50	92.60	185.00	265.00	60.00	112.00	190.00	262.00
Al-11	BJ	5.14	293.00	5.43	284.80	4.00	III	72.00	126.00	290.00	290.00	63.00	119.00	190.00	284.00

Table A3 — Database storage for concentric-exterior beam-column joints (51/51)

No. ID	Failure Mode	Column axial load [%Agf'c]	Maximum Loading				Loading Curve								
			Positive		Negative		Type of Loading	Positive Loading				Negative Loading			
			P_{max}[kN]	Drift[%]	P_{max}[kN]	Drift[%]		$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$	$P_{0.5\%}$	$P_{1.0\%}$	$P_{2.0\%}$	$P_{4.0\%}$
FB-1	J	6.89	60.00	1.50	57.60	2.00	III	3.05	4.38	5.57	5.70	2.70	4.35	4.90	5.50
FB-2	BJ	6.89	45.00	2.80	54.60	2.70	III	2.55	4.09	4.80	5.05	3.25	4.51	5.10	5.10
FB-3	J	24.11	67.50	3.00	58.70	2.80	III	3.30	5.03	6.05	6.52	3.20	4.80	5.70	5.80
FB-4	J	24.11	70.00	2.80	59.00	3.00	III	3.30	4.90	5.90	6.20	2.65	4.65	5.70	5.70
Ce-1	BJ	10.00	200.00	2.05	171.00	2.05	III	100.00	150.00	195.00	200.00	115.00	168.00	170.00	171.00
Ce-2	BF	10.00	210.00	3.59	183.00	3.85	III	95.50	171.00	197.00	215.00	95.00	160.00	172.00	180.00
Ce-3	J	10.00	186.00	1.79	177.00	1.90	III	85.00	115.00	162.00	142.00	92.00	138.00	165.00	144.00
Ce-4	BJ	10.00	227.00	2.82	200.00	2.05	III	120.00	161.00	215.00	230.00	86.00	135.00	200.00	150.00
Ce-5	J	10.00	291.00	2.05	281.00	2.05	III	88.70	137.00	220.00	206.00	64.50	132.00	191.00	154.00
He-1	BF	1.45	205.00	7.00	200.00	7.10	III	90.00	140.00	181.00	193.00	130.00	156.00	170.00	186.00
He-2	BJ	1.61	218.00	8.10	201.00	6.50	III	95.00	170.00	195.00	210.00	105.00	135.00	148.00	178.00
He-3	BJ	1.56	208.00	7.80	170.00	6.70	III	109.00	178.00	190.00	205.00	63.60	135.00	150.00	165.00
He-4	BJ	1.53	200.00	8.00	180.00	5.60	III	145.00	190.00	217.00	227.00	68.00	108.00	125.00	150.00
He-5	BF	1.29	214.00	7.00	185.00	3.60	III	144.00	170.00	197.00	215.00	87.00	125.00	164.00	180.00
He-6	BF	1.26	195.00	6.00	224.00	6.90	III	80.50	155.00	175.00	201.00	100.00	158.00	180.00	200.00
He7	BF	1.39	217.00	7.00	190.00	5.60	III	115.00	178.00	193.00	220.00	71.00	116.00	145.00	175.00
LK-1	BF	10.00	197.50	6.00	189.60	5.00	III	115.00	145.00	168.00	185.00	112.00	135.00	162.00	180.00
LK-2	BJ	10.00	173.46	4.80	169.05	5.00	III	80.00	129.00	143.00	161.00	86.00	106.00	141.00	158.00

APPENDIX B

Example on Detailed Calculation Using SST Model

Table B1 below shows the calculation example for an interior joint shear strength of Specimen UM-60 tested by Goto and Joh (2004) (Fig. B1). The total length of the column is 1750 mm. The lengths of the beams on either side of the joint are 1350 mm.

Table B1 — Calculation example using SST model

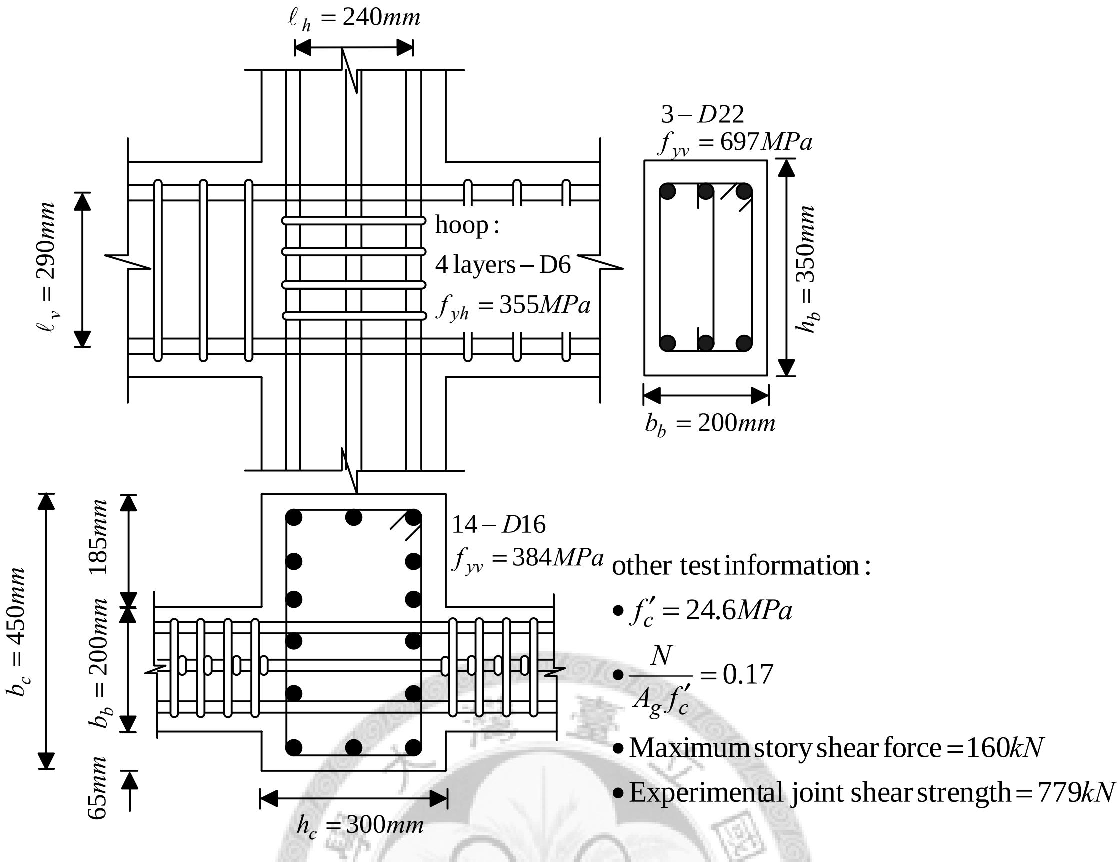
	Analysis 1	Analysis 2	Analysis 3
Input	$\theta = \tan^{-1}\frac{\ell_v}{\ell_h} = \tan^{-1}\frac{290}{240} = 50.4^\circ$ $f'_c = 24.6\,MPa\,;\, f_{yv} = 384\,MPa\,;\, f_{yh} = 355\,MPa$ $A_{th} = 3\times1\times28.3\,mm^2 = 85\,mm^2$ $A_{tv} = 1\times201\,mm^2 = 201\,mm^2$ $F_{yh} = 85\times355 = 30.1\,kN$ $F_{yv} = 201\times384 = 77.2\,kN$		
Depth of compression zones of beam and column	$c_c = \left(0.25 + 0.85\frac{N}{A_g f'_c}\right)h_c$ $= (0.25 + 0.85\times0.17)300 = 118\,mm$	Joint maximum response : ● Maximum story shear force = $160\,kN$ ● Corresponding maximum shear at beam	

	Analysis 1	Analysis 2	Analysis 3
Depth of compression zones of beam and column (cont'd)	$c_b = \dfrac{A_s f_y}{0.85 f_c' \beta_1 b_b}$ $= \dfrac{3\times387\times697}{0.85\times24.6\times0.85\times200}$ $= 228\ mm$	$\dfrac{160\times1750/2}{1350+300/2} = 93.3\ kN$ ● The maximum bending moments occurred at joint interface for column and beam respectively are : $M_{col} = 160\times(875-175)/1000 = 112\ kN-m$ $M_{beam} = 93.3\times1350 = 126\ kN-m$ ● Through sectional analysis, $c_c = 139\ mm$ $c_b = 131\ mm$	
Depth of strut	$a_s = c_c \sin\theta + c_b \cos\theta = 236\ mm$	$a_s = c_c \sin\theta + c_b \cos\theta = 191\ mm$	
Effective joint width	$b_j = b_b + \sum \min\left(2\times\dfrac{c_c}{3}; x_i\right)$ $= 200 + \min\left(2\times\dfrac{118}{3}; 185\right) + \min\left(2\times\dfrac{118}{3}; 65\right)$ $= 344\ mm$	$b_j = b_b + \sum \min\left(2\times\dfrac{c_c}{3}; x_i\right)$ $= 200 + \min\left(2\times\dfrac{139}{3}; 185\right) + \min\left(2\times\dfrac{139}{3}; 65\right)$ $= 358\ mm$	
Force Distribution	$\gamma_h = (2\tan\theta - 1)/3 = 0.47$ $\gamma_v = (2\cot\theta - 1)/3 = 0.22$		Through solution procedure : $V_h = 584.6\ kN$ $F_h = 31.0\ kN$ $F_v = 77.2\ kN$

	Analysis 1	Analysis 2	Analysis 3
Strain compatibility	Assume $\varepsilon_h = \varepsilon_v = 0.002$ and $\varepsilon_d = -0.001$ $\varepsilon_r = \varepsilon_v + \varepsilon_h - \varepsilon_d = 0.005$		$\varepsilon_h = \dfrac{F_h}{A_{th} E_s} = 0.0018$ $\varepsilon_v = \dfrac{F_v}{A_{tv} E_s} = 0.0019$ $\varepsilon_d = -0.0011$ $\varepsilon_r = 0.0048$
Softening coefficient	$\zeta = \dfrac{5.8}{\sqrt{f_c'}} \dfrac{1}{\sqrt{1+400\varepsilon_r}} \le \dfrac{0.9}{\sqrt{1+400\varepsilon_r}}$ $\zeta = \dfrac{3.35}{\sqrt{f_c'}} = \dfrac{3.35}{\sqrt{24.6}} = 0.68 > 0.52$; take 0.52		Through solution procedure : $\zeta = 0.68 > 0.53$; take 0.53
Strut-and-tie index	$\overline{K}_h = 1/(1-0.2\gamma_h - 0.2\gamma_h^2) = 1.16$ $\overline{K}_v = 1/(1-0.2\gamma_v - 0.2\gamma_v^2) = 1.06$ $\overline{F}_h = \gamma_h \times \left(\overline{K}_h \zeta\ f_c'\ b_j\ a_s\right) \times \cos\theta$ $= 362kN$ $\overline{F}_v = \gamma_v \times \left(\overline{K}_v \zeta\ f_c'\ b_j\ a_s\right) \times \sin\theta$ $= 184kN$	$\overline{K}_h = 1.16$ $\overline{K}_v = 1.06$ $\overline{F}_h = 376.7kN$ $\overline{F}_v = 191.4kN$	-

	Analysis 1	Analysis 2	Analysis 3
Strut-and-tie index (cont'd)	$K_h = 1 + \left(\overline{K}_h - 1\right)\frac{F_{yh}}{\overline{F}_h} = 1.013 \le \overline{K}_h$ $K_v = 1 + \left(\overline{K}_v - 1\right)\frac{F_{yv}}{\overline{F}_v} = 1.023 \le \overline{K}_v$	$K_h = 1.013 \le \overline{K}_h$ $K_v = 1.024 \le \overline{K}$	
Shear Strength	$V_{SST\_1} = \left(K_h + K_v - 1\right)\zeta\, f_c'\, b_j\, a_s \cos\theta$ $= 685kN$	$V_{SST\_2} = 577k$	$V_{SST\_3} = V_h = 585kN$

(units : $1\ in. = 25.4\ mm; \quad 1\ kip = 4.45\ kN$)



other test information:

- $f_c' = 24.6MPa$
- $\frac{N}{A_g f_c'} = 0.17$
- Maximum story shear force $= 160kN$
- Experimental joint shear strength $= 779kN$

Figure B1 — Detailing of Specimen UM-60 (Goto and Joh 2004)

APPENDIX C

Table C-1 —Statistical value of shear strength ratios between experimental and predicted values for concentric exterior joints calculated using ℓ_{dh} (1/2)

Specimens		$V_{test}[kN]$	$\ell_{dh}[mm]$	$\frac{V_{test}}{V_{ACI\,318-08}}$	$\frac{V_{test}}{V_{ACI\,352-02}}$	$\frac{V_{test}}{V_{proposed}}$
Hanson (1971)	S4	814.29	289.2	1.21	1.35	1.21
	S5	884.75	289.2	1.34	1.48	1.34
Yamaguchi et al. (1980)	N22	668.87	455.00	0.58	0.68	0.58
	N25	904.94	457.00	0.85	0.99	0.85
	N29	802.10	416.00	0.82	0.96	0.82
	N35	598.97	426.00	0.59	0.69	0.59
	L25	649.29	457.00	0.59	0.70	0.59
	2P13	314.64	210.00	1.16	1.36	1.16
	2P16	278.90	213.00	1.04	1.22	1.04
	4P16	276.78	213.00	0.99	1.17	0.99
	2P19	261.51	215.00	0.96	1.13	0.96
	S16	280.23	202.50	1.08	1.27	1.08
Paulay and Scarpas (1981)	Unit 1	750.89	392	0.88	0.99	0.88
	Unit 2	988.29	392	1.16	1.31	1.16
	Unit 3	754.46	392	0.81	0.91	0.81
Kanada et al. (1984)	U41L	364.00	228	1.03	1.10	1.03
	U42L	361.50	228	0.96	1.03	0.96
	U40L	275.00	228	0.82	0.87	0.82
Ehsani and Wight (1985)	Spec 1B	555.45	187.96	1.70	1.82	1.70
	Spec 3B	589.68	187.96	1.64	1.76	1.64
	Spec 4B	636.80	187.96	1.69	1.82	1.69
	Spec 5B	568.26	238.76	1.42	1.51	1.42
	Spec 6B	452.32	238.76	0.88	0.94	0.88
Ehsani et al. (1987)	Spec 1	644.50	274.32	0.86	0.91	0.86
	Spec 2	789.10	274.32	1.03	1.10	1.03
	Spec 3	671.10	233.68	1.19	1.28	1.19
	Spec 4	726.70	236.22	1.25	1.34	1.25

Table C-1 —Statistical value of shear strength ratios between experimental and predicted values for concentric exterior joints calculated using ℓ_{dh} (2/2)

Specimens		$V_{test}[kN]$	$\ell_{dh}[mm]$	$\frac{V_{test}}{V_{ACI\,318-08}}$	$\frac{V_{test}}{V_{ACI\,352-02}}$	$\frac{V_{test}}{V_{proposed}}$
Alameddine (1991)	LL8	860.66	266.7	1.21	1.28	1.21
	LH8	838.49	266.7	1.18	1.24	1.18
	HH8	985.67	266.7	1.38	1.46	1.38
	HL8	986.78	266.7	1.38	1.46	1.38
	LL11	769.14	266.7	0.94	0.99	0.94
	LH11	934.28	266.7	1.14	1.21	1.14
	HH11	1021.01	266.7	1.25	1.32	1.25
	HL11	967.81	266.7	1.18	1.25	1.18
	LL14	878.01	266.7	0.96	1.02	0.96
	LH14	890.63	266.7	0.98	1.03	0.98
	HH14	1032.75	266.7	1.13	1.20	1.13
Fujii and Morita (1991)	B1	255.00	197	1.07	1.24	1.07
	B2	214.00	197	1.07	1.24	1.07
	B3	273.00	197	1.15	1.33	1.15
	B4	287.00	197	1.21	1.40	1.21
Castro and Imai (2004)	A-No.1	1064.30	300	1.25	1.34	1.25
	A-No.2	1131.90	300	1.13	1.20	1.13
	A-No.5	930.00	300	1.69	1.80	1.69
	A-No.7	1109.00	300	1.31	1.39	1.31
	A-No.10	1070.00	300	1.26	1.35	1.26
Hwang et al. (2005)	3T4	1110.00	278	0.91	1.07	0.91
	2T5	1162.00	278	0.95	1.11	0.95
	1T55	1126.00	278	0.96	1.12	0.96
	3T44	1065.00	278	1.04	1.18	1.04
	3T3	1132.00	312	1.17	1.32	1.17
	2T4	1080.00	312	1.10	1.25	1.10
	1T44	1039.00	312	1.04	1.18	1.04
Lee and Ko (2007)	S0	699.00	528	0.62	0.71	0.62
	W0	778.00	330	0.72	0.96	0.87

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