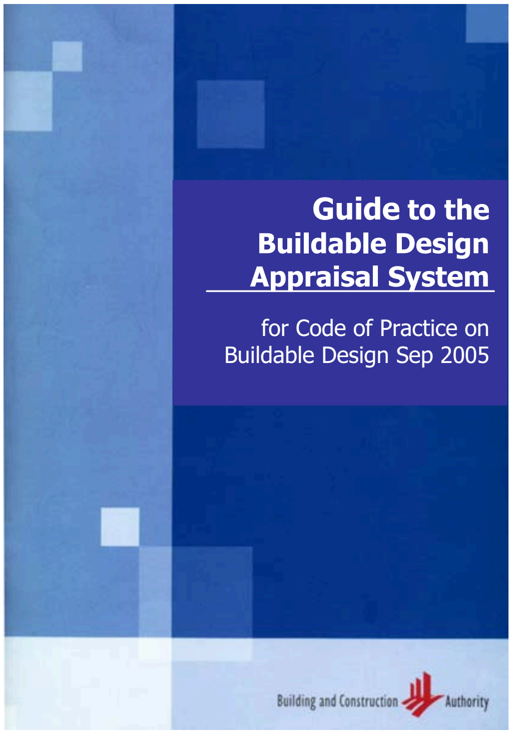
Guideline
BCA
Technology Development Division

Guide to the
Buildable Design Appraisal System



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This Guide is subjected to revision from time to time. Nothing herein shall be construed to exempt the person submitting an application or any plans from otherwise complying with the provisions of the Building Control Act (Cap 29) or any rules and/or guidelines made thereunder or any Act or rules and/or guidelines for the time being in force.

Building and Construction Authority

Sep 2005

Content Page

Content **Page**

Introduction

This Guide serves to advise the industry on the computation of buildability score using the Buildable Design Appraisal System. The guide is revised to the requirement specified in Code of Practice on Buildable Design September 2005. Interpretation on the terms and method of measurement/computation are included to ensure that the buildability scores are computed by the industry in a consistent manner. More examples of buildable design scoring are given to illustrate the computation sequence and methodology.

The buildability score of a design consists of 3 main parts:

Part 1: Structural Systems (maximum 50 points);

Part 2: Wall Systems (maximum 40 points);

Part 3: Other Buildable Design Features (maximum 10 points + bonus points for single integrated components)

Indices for structural systems are indicated in Table 1. Indices for wall systems are indicated in Table 2. Buildability points for other buildable design features are indicated in Table 3.

If you have other queries that are not addressed in this Guide, please contact us at:

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General Guidelines

- ❖ Gross Floor Area
- ❖ Constructed Floor Area
- ❖ Minimum Buildability Score
- ❖ Decimal Points
- ❖ Module
- ❖ Structures to be Included in Computation
- ❖ Basics of Buildable Design Appraisal System
- ❖ Worked Examples

1 Gross Floor Area

The gross floor area (GFA) of a project is used to determine whether a project is required to comply with the minimum buildability score requirement or not. Once a project is affected by the buildability legislation (GFA of at least 2000 square metres), then depending on the amount of GFA involved and the category of building work, the corresponding minimum buildability score as set out in the Code of Practice on Buildable Design (COP) will apply.

For new developments, the GFA would be as spelt out in the planning permission issued by URA, including any bonus GFA granted (e.g. for balconies etc).

In the case of projects involving additions and alterations (A&A) work, the GFA would be the total GFA of all new floor and/or reconstruction of existing floor. As such, an A&A project could be affected by the legislation even if there is no increase in GFA to the existing building or the increase in total GFA of the existing development is less than 2000 square metres as illustrated by the following examples:-

Example 1

Proposed A&A to an existing industrial development involving change of use and a new extension

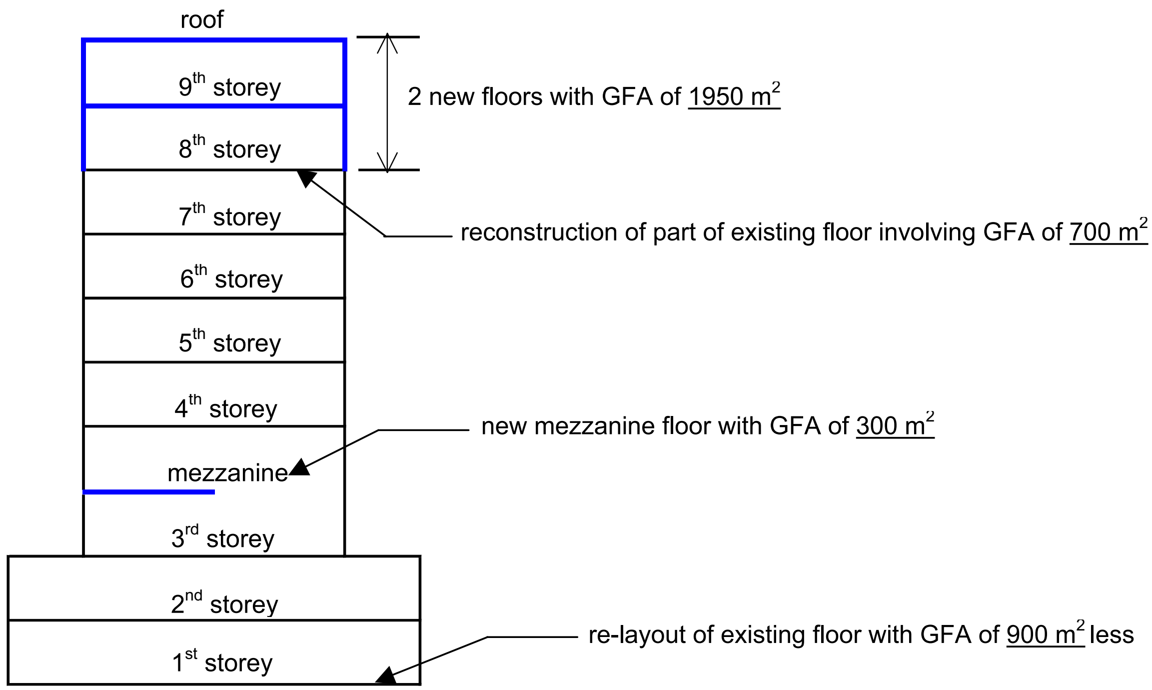
PLAN

In this example, there is a decrease in GFA of 2000 m^2 of the existing building due to the change of use of part of the building from warehouse to carpark. At the same time, there is an increase in GFA of 2000 m^2 to the existing building from the new side extension. Overall, there is no increase in the total GFA of the A&A project.

However, the above project is subjected to the buildability legislation. This is because the legislation looks at GFA of constructed floors, whether new or reconstructed. The amount of GFA in this case is 2000 m^2 (assuming that there is no work done for the portion of the building undergoing a change of use).

Example 2

Proposed A&A and addition of a new mezzanine floor and 2 new storeys to an existing 7-storey commercial building



In this example, the net change in GFA of the existing development is 1350 m^2 while the total GFA of new and reconstructed floors is 2950 m^2. The breakdown of the respective GFA is as shown in the table below.

	Net Change in GFA	Total GFA of new and reconstructed floors
Re-layout of 1st storey	- 900 m^2	0 m^2
New mezzanine floor	+ 300 m^2	+ 300 m^2
Reconstruction of 8th storey	no change in GFA	+ 700 m^2
Construction of 2 new floors	+ 1950 m^2	+ 1950 m^2
Total GFA	**+1350 m^2**	**+ 2950 m^2**

As in Example 1, by virtue of the definition of GFA in the context of A&A work, the above project is <u>subjected</u> to the buildable design legislation since the total GFA of the new and reconstructed floors is 2950 m2. This is despite the increase in the total GFA of the existing building being only 1350 m^2 which is less than 2000 m^2.

2 Constructed Floor Area

Once a project is subjected to the minimum buildability score requirement, all constructed floor areas (including reconstructed floor areas) are to be considered when computing the minimum buildability score (except minor structures as defined in item 6). The constructed floor area is also used to derive the overall buildability score of a project comprising multiple blocks, by pro-rating the buildabilty scores of each of the blocks with its constructed floor area and summing up the pro-rated scores (please also refer to item 7).

3 Minimum Buildability Score

Different minimum buildability scores are given for different categories of development. For a new development, the corresponding minimum buildability score can be found in the COP stipulated under “Table B – Minimum Buildability Score for New Work”.

For a mixed development, the minimum buildability score will be pro-rated according to the GFA of each type of development.

For an A&A project with the A&A work being carried out outside the existing building, such A&A work is considered as new work. As such, the corresponding minimum buildability score required to be complied by the A&A project is also set out in the COP under “Table B - Minimum Buildability Score for New Work”. Examples of A&A work being carried out outside the existing building are those that are constructed outside the envelope of the existing building, such as

- a new extension to the existing building,
- additional storeys over the existing roof etc.

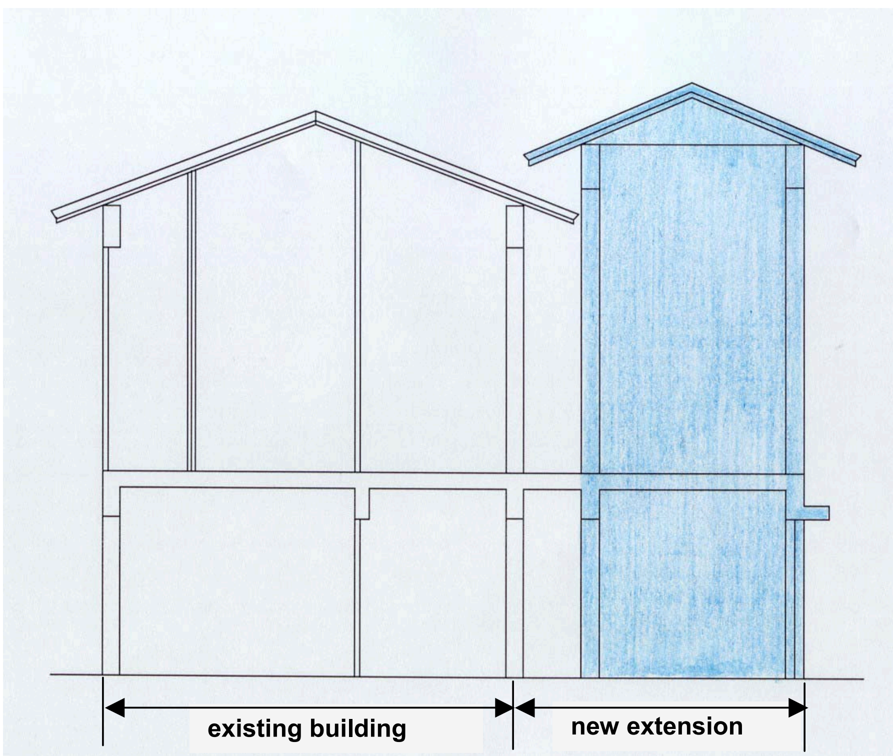


Illustration 1: Project with A&A work carried out outside an existing building - Minimum buildability score for New Work shall apply

For a project with A&A work being carried out within the existing building (envelope), the minimum buildability score is as shown under "Table C – Minimum Buildability Score for A&A Work" in the COP. Examples of such A&A work are

- a new mezzanine floor,
- the slabbing over of an existing void within a building,
- the replacement or reconstruction of existing floor etc.

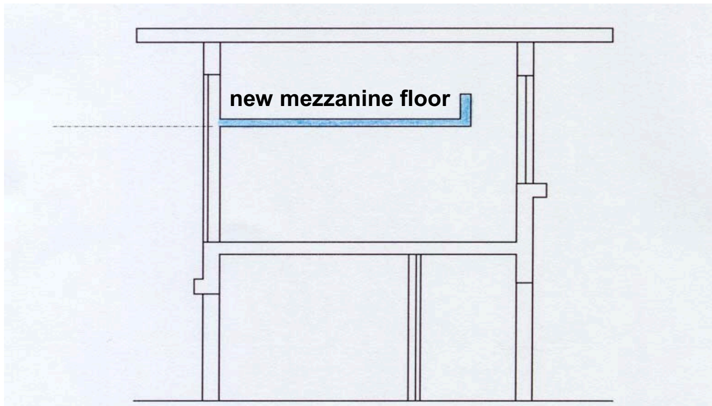


Illustration 2: Project with A&A work carried out <u>within</u> an existing building - Minimum buildability score for A&A Work shall apply

In the case of a project with A&A work being carried out both within and outside the existing building, the minimum buildability score will be pro-rated according to the GFA of the A&A work outside the existing building (new work – Table B) and the GFA of the A&A work within the existing building (Table C).

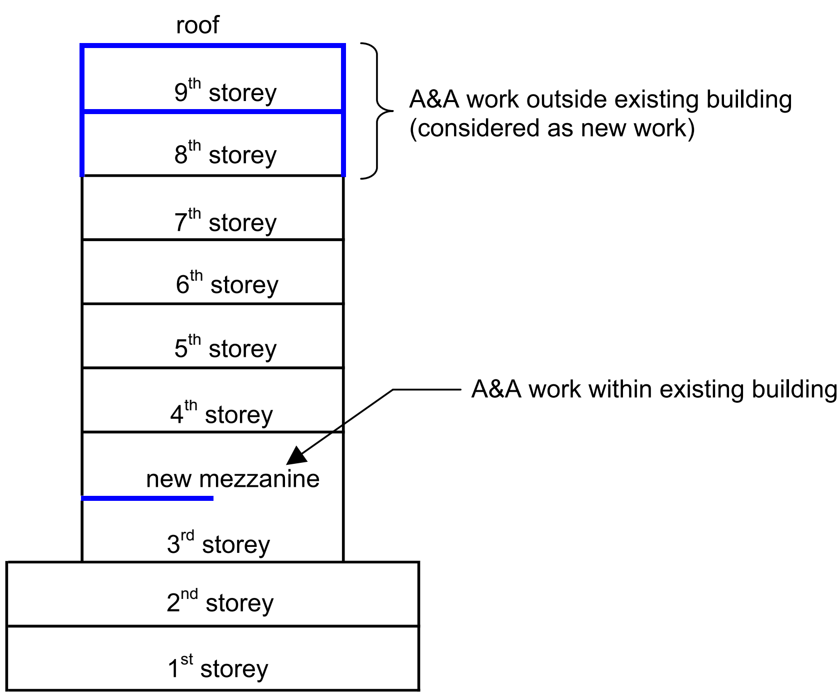


Illustration 3: Project with A&A work carried out both <u>within</u> and <u>outside</u> an existing building - Minimum buildability score for A&A Work shall be pro-rated according to the GFA of each type of work

4 Decimal Points

All calculations should be rounded off to the nearest 2 decimal places except for the overall buildability score and percentage of coverage for other buildable design features, which should be expressed as an integer.

5 Module

The basic module (M) denotes 100mm. For example, 3M denotes 300mm and 0.5M denotes 50mm.

6 Structures to be Included in Computation

All major structures, including clubhouse and multi-storey carpark, are to be considered when computing the buildability score. Minor structures such as 22 KV substation, guard post, bin centre and trellis can be excluded from the computation, provided that they are not within or structurally linked to the main building.

7 Basics of Buildable Design Appraisal System (BDAS)

The Buildable Design Appraisal System (BDAS) was developed to measure the potential impact of a building design on the usage of labour. The appraisal system provides a method to compute the Buildability Score of a design. It consists of three main parts :-

(a) Structural System (including Roof System) (50 points max)

(b) Wall System (40 points max);

(c) Other Buildable Design Features (10 points max + bonus points for single integrated components)

The Buildability Score (BS) of a building design is expressed as :

$BS_{\text{bldg}} = \sum(BS_{\text{Structural System}} + BS_{\text{Wall System}} + BS_{\text{Other Buildable Design Features}})$

where

$BS_{\text{Structural System}}$ = 50 [$\sum$ (% of total floor area of the building using a particular structural system x respective labour saving index for structural system (Table 1))]

$BS_{\text{Wall System}}$ = 40 [$\sum$ (% of total wall length of the building using a particular wall system x respective labour saving index for wall system (Table 2))]

$BS_{\text{Other Buildable Design Features}}$ = $\sum$ [N Value obtained for other buildable design features used (Table 3)]

For projects that consist of more than one building, the buildability score for each building should be computed first before deriving the buildability score for the whole project. In buildability score computation, one can consider part of the building or a number of buildings as a block for simplicity. Service structures such as toilets, staircases, lift shafts, corridors, link bridges should be grouped together with a particular building or block for which the services are proposed.

The buildability score of the whole project (BS_{proj}) is then derived by summing up the multiplication of the respective buildability score of the individual building or block with its percentage of the total floor area of that building or block in the project.

It can be expressed as :

$BS_{\text{proj}} = \sum[BS_{\text{bldg or block}} \times (A_{st})_{\text{bldg or block}} / (A_{st})_{\text{proj}}]$

where $(A_{st})_{\text{bldg or block}}$ = Total floor area which includes roof (projected area) and basement area of the building or block

$(A_{st})_{\text{proj}}$ = Summation of total floor area of all buildings or blocks in a project (i.e. $\sum(A_{st})_{\text{bldg or block}}$)

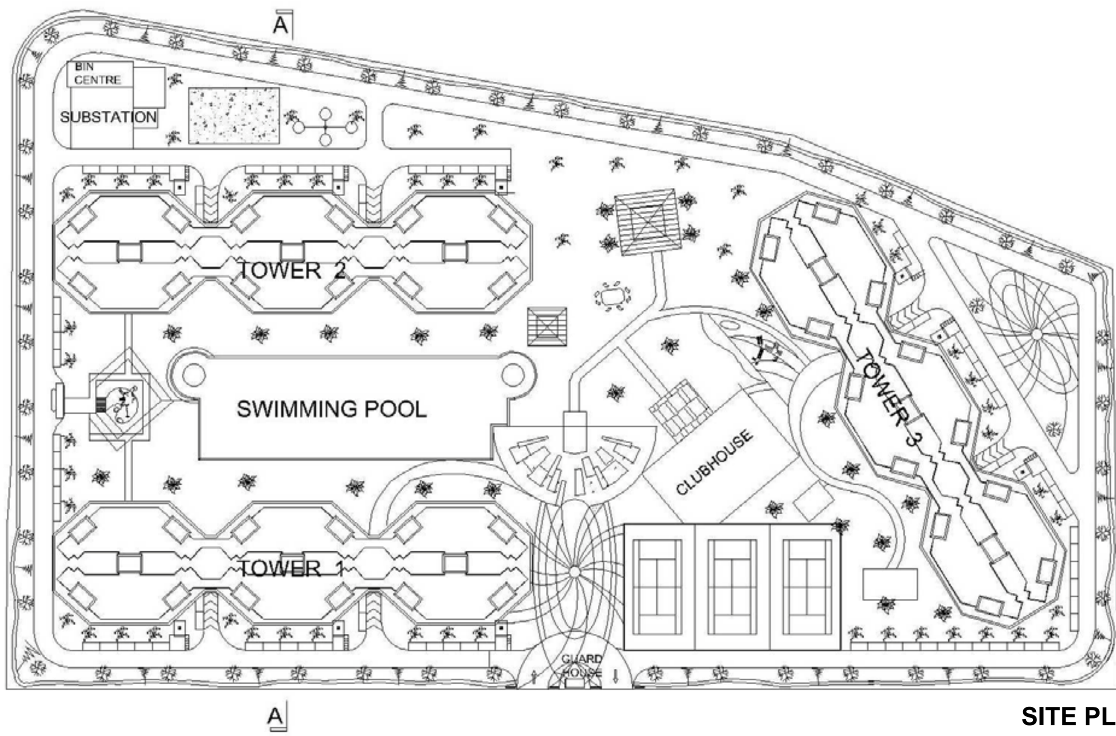
The worked examples in the next section will give some guidelines on the approach in grouping the building structures into different blocks before proceeding with the details of the buildability score computation.

8 Worked Examples

Example G1: Residential Development with Communal Facilities and Basement Carpark

A. Project Information

This project consists of three 10-storey residential tower blocks with basement carpark, swimming pool, clubhouse and communal facilities.



SITE PLAN

B. Demarcation of Blocks

For buildability score computation, the development can be classified as 4 blocks.

They are :-

(a) Block 1 – Tower 1

(b) Block 2 – Tower 2

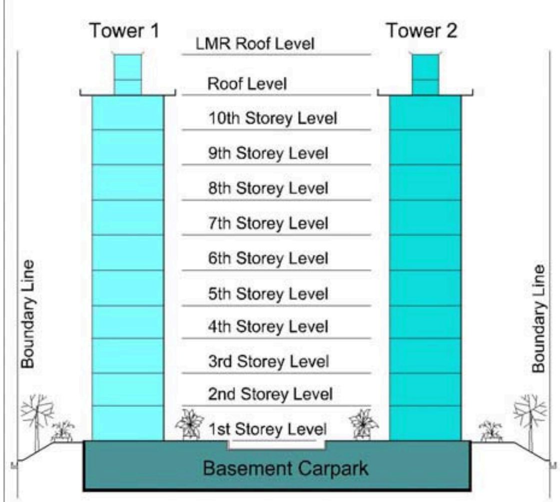
(c) Block 3 – Tower 3

(d) Block 4 – Clubhouse, environmental deck and basement carpark

The buildability score of the project can be obtained by

$$\begin{aligned} BS_{proj} = \; & [(BS_{block1} \times (A_{st})_{block1} / (A_{st})_{proj}) + \\ & (BS_{block2} \times (A_{st})_{block2} / (A_{st})_{proj}) + \\ & (BS_{block3} \times (A_{st})_{block3} / (A_{st})_{proj}) + \\ & (BS_{block4} \times (A_{st})_{block4} / (A_{st})_{proj}) \end{aligned}$$

Note: Detached 22 KV substation and bin centre are excluded in buildability score computation.

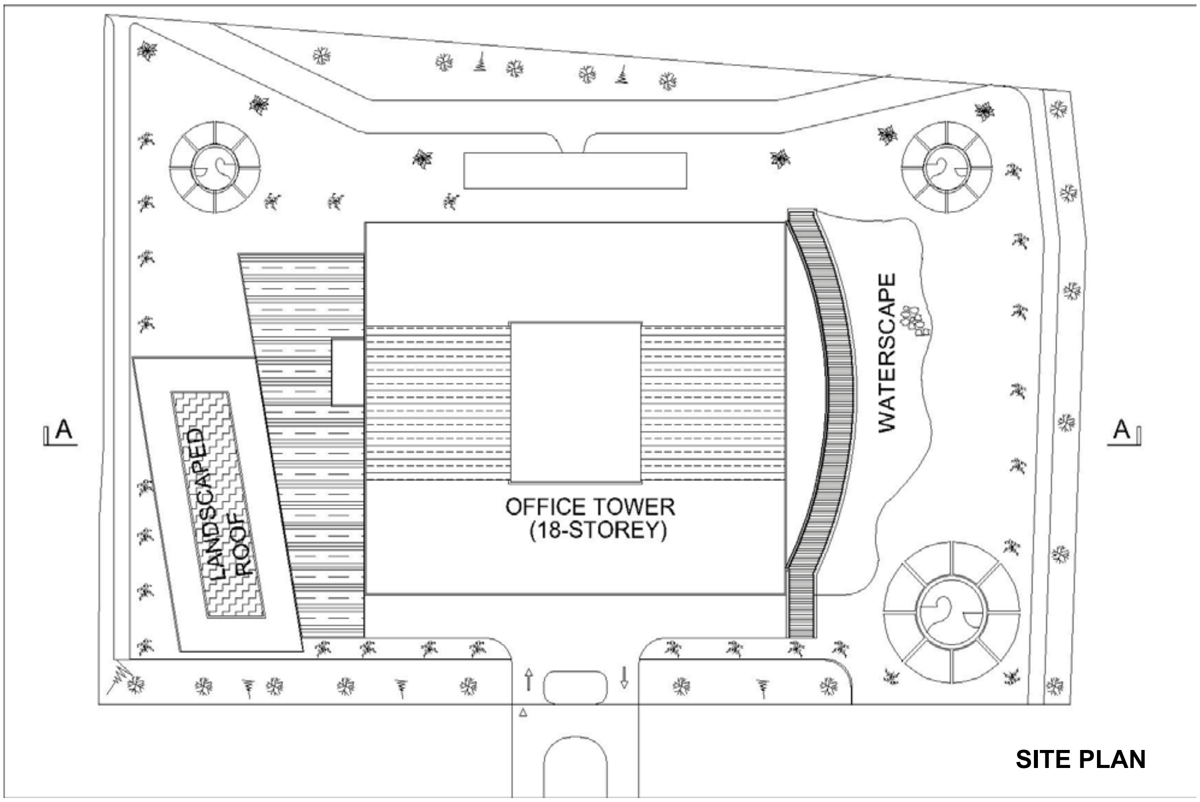


Schematic Section A-A

Example G2: Commercial Development with Elevated Carparks

A. Project Information

This project comprising an 18-storey office tower with a 2-storey retail podium, 3 storey elevated carparks and 3 levels of retail shops at basement.



SITE PLAN

B. Demarcation of Blocks

For buildability score computation, the development can be classified as 3 blocks.

They are :-

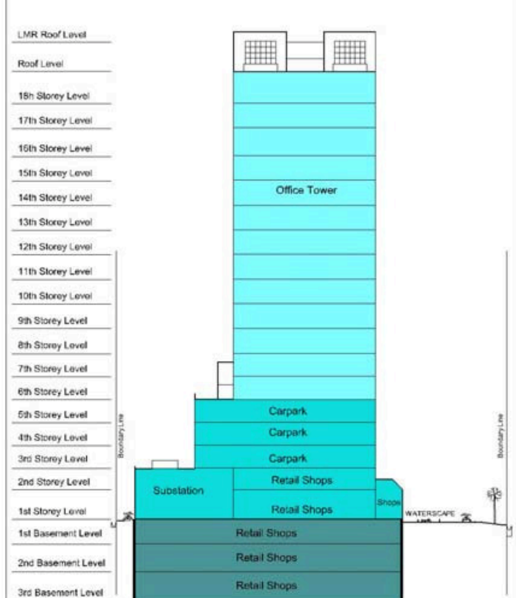
(a) Block 1 – Office Tower

(b) Block 2 – Elevated Carparks and Retail Shops and Substation

(c) Block 3 – Retail Shops at Basement

The buildability score of the project can be obtained by

$$BS_{proj} = [(BS_{block1} \times (A_{st})_{block1} / (A_{st})_{proj}) + (BS_{block2} \times (A_{st})_{block2} / (A_{st})_{proj}) + (BS_{block3} \times (A_{st})_{block3} / (A_{st})_{proj})]$$

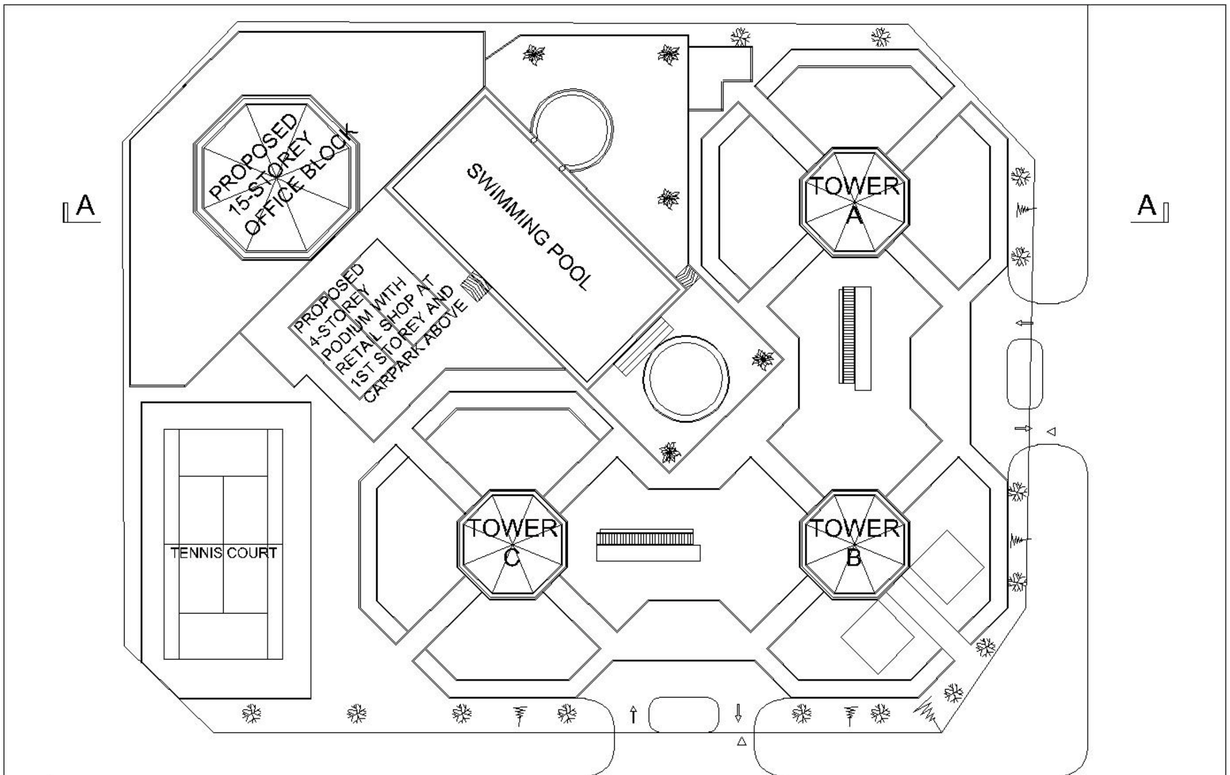


Schematic Section A-A

Example G3: Mixed Development with Carparks

A. Project Information

This project is a 15-storey mixed development comprising three residential tower blocks, one commercial office block with a 4-storey podium with retail shops and carparks.



SITE PLAN

B. Demarcation of Blocks

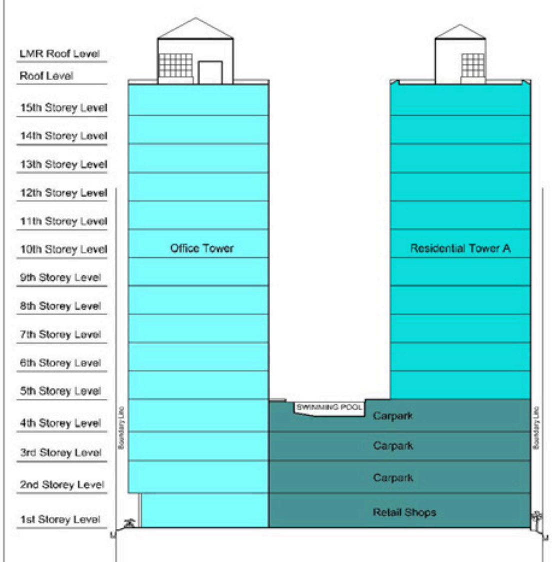
For buildability score computation, the development can be classified as 5 blocks.

They are :-

(a) Block 1 – Residential Tower A
(b) Block 2 – Residential Tower B
(c) Block 3 – Residential Tower C
(d) Block 4 – Office Tower
(e) Block 5 – Podium with Retail Shops and Carparks

The buildability score of the project can be obtained by

$$
\begin{aligned}
BS_{proj} = \; & [(BS_{block1} \times (A_{st})_{block1} / (A_{st})_{proj}) + \\
& (BS_{block2} \times (A_{st})_{block2} / (A_{st})_{proj}) + \\
& (BS_{block3} \times (A_{st})_{block3} / (A_{st})_{proj}) + \\
& (BS_{block4} \times (A_{st})_{block4} / (A_{st})_{proj}) + \\
& (BS_{block5} \times (A_{st})_{block5} / (A_{st})_{proj})]
\end{aligned}
$$

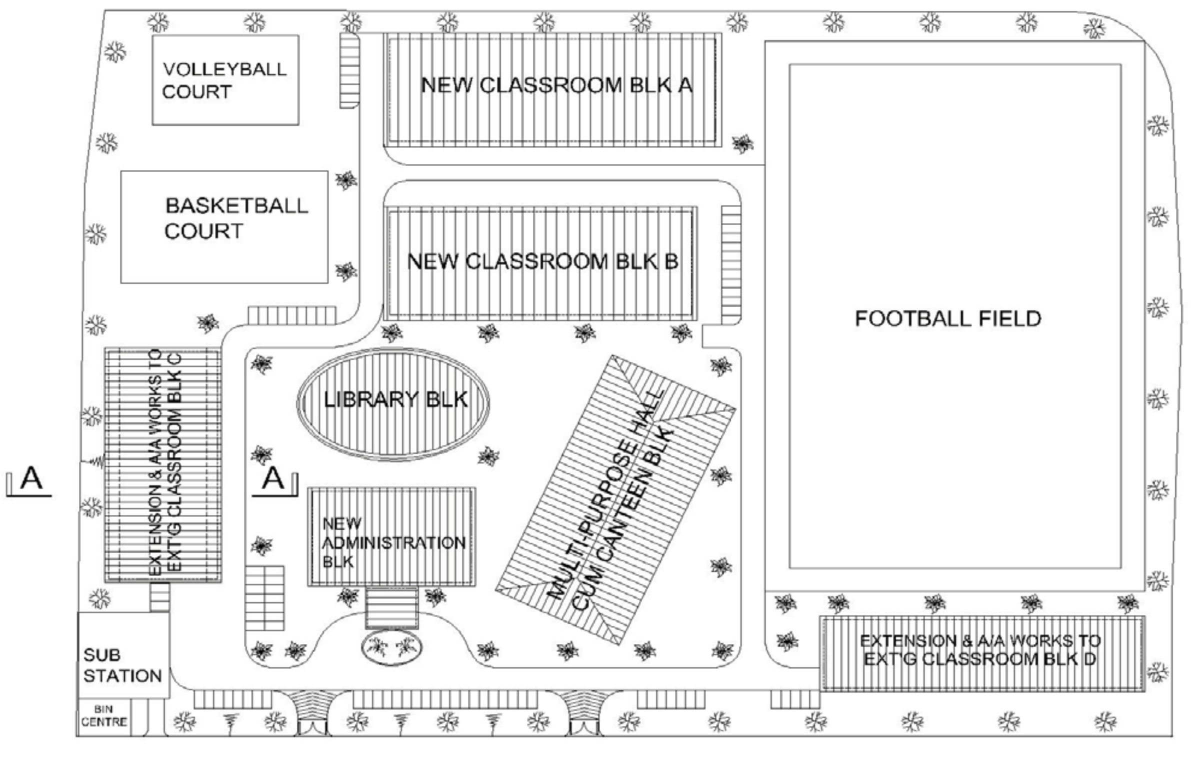


Schematic Section A-A

Example G4: Institutional Development with New Extension and Addition & Alteration Works to Existing School Buildings

A. Project Information

This project consists of two 4-storey classroom blocks, a 2- storey multi-purpose hall cum canteen block, one administration block, one library block & extension and additions & alterations to two 4-storey existing classroom blocks.



SITE PLAN

B. Demarcation of Blocks

For buildability score computation, the development can be classified as 7 blocks.

They are :-

(a) Block 1 – New classroom Block A
(b) Block 2 – New classroom Block B
(c) Block 3 – Multi-purpose Hall cum Canteen Block
(d) Block 4 – Extension & A/A works to existing classroom Block C
(e) Block 5 – Extension & A/A works to existing classroom Block D
(f) Block 6 – Library Block
(g) Block 7 – New Administration Block

The buildability score of the project can be obtained by

$BS_{proj} = \sum[BS_{bldg\ or\ block} \times (A_{st})_{bldg\ or\ block} / (A_{st})_{proj}]$

Note : Detached 22 KV substation and bin centre are excluded in buildability score computation.

C. Considerations for Extension and Additions & Alterations Works

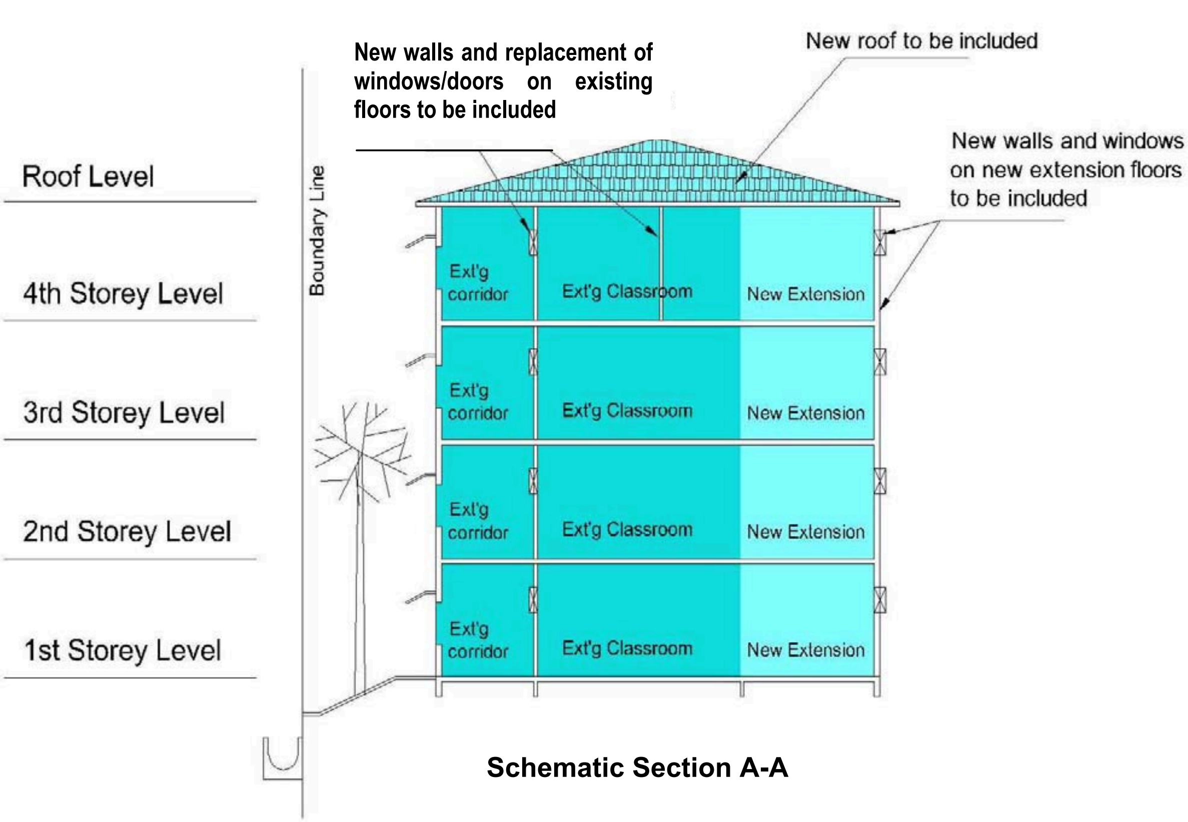
All new walls and doors/windows on both the new extension floors and existing floors are to be considered in the buildability score computation, as illustrated in the Schematic Section A-A below.

For this case, the apportioned buildability score of Block 4 (same as for Block 5) attributing to the buildability score of project will be as follows:-

$BS_{block\ 4} \times (A_{st})_{block\ 4} / (A_{st})_{proj}$

where

$(A_{st})_{block\ 4}$ = Total new floor areas extension
= $\sum$(Extended Floor areas from 1st to 4th Sty + Roof area)



Schematic Section A-A

D. Change of Use to Existing Building with Extension & Additions and Alterations Works

The same principle adopted in the above Section C is applicable to all other types of development involving change of use to existing buildings with extension & additions and alterations works.

Part 1 Structural Systems

- Labour Saving Indices for Different Structural Systems
- Structural Areas Consideration
- Prefabricated Reinforcement Consideration
- Structural Systems
- Measurement
- Worked Examples

1 Labour Saving Indices for Different Structural Systems

The labour saving index derived for each structural system and roof system is as shown in the following Table 1. An index of 0.03 each would be given if prefabricated reinforcement/cage is used in cast in-situ slab, beam and column.

Table 1 Structural Systems - Ss Value

Structural System	Description	Labour Saving Index S_s
Precast Concrete System	Full precast	1.00
	Precast column/wall with flat plate/flat slab (1)	0.95
	Precast beam and precast slab	0.90
	Precast beam and precast column/wall	0.85
	Precast column/wall and precast slab	0.80
	Precast beam only	0.75
	Precast slab only	0.75
	Precast column/wall only (1)	0.75
Structural Steel System (applicable only if steel decking or precast slab is adopted)	Steel beam and steel column (without concrete encasement)	0.95
	Steel beam and steel column (with concrete encasement)	0.85
Cast In-situ System	Flat plate (1)	0.90
	Flat slab (1)	0.85
	One-way banded beam (1)	0.75
	Two-way beam (1) (slab/beam(2) >10)	0.65
	Two-way beam(1) (slab/beam(2) ≤ 10)	0.50
Roof System	Integrated metal roof on steel truss	0.90
	Metal roof on steel truss or timber truss	0.85
	Tiled roof on steel beam or precast concrete beam or timber beam	0.75
	Metal roof on cast in-situ beam	0.60
	Tiled roof with cast in-situ beam	0.55

NOTE:
(1) For cast in-situ floor with cast in-situ transfer beam, an index of -0.10 shall be applied to the entire cast in-situ floor area. This requirement does not apply to cast in-situ floor with transfer beam designed for ramp access.
(2) Slab/beam refers to the value of slab area over number of beams.

The respective labour saving indices for other common structural systems that are not shown in Table 1 are listed as follows :

LABOUR SAVING INDEX (LSI)		
DESCRIPTION	SIMILAR TO	LSI TO BE USED
Precast hollow core slab	Precast concrete slab	Refer to Table 1
Precast planks (half slab)	Precast concrete slab	Refer to Table 1
Waffle slab (cast in-situ)	Cast in-situ slab (slab/beam < 10)	Refer to Table 1
Waffle slab (precast)	Precast concrete slab	Refer to Table 1
Precast shell column/beam	Precast column/beam	Refer to Table 1
Steel column with concrete infill	Steel column without concrete encasement	Refer to Table 1
One-way beam*	One-way banded beam	Refer to Table 1
Skylight	-	Ss Value = 1.00

*Refers to one-directional beams. It does not refer to the design of the slab (contrast with one-way slab design).

Indices for other systems that are not shown in these tables shall be determined by BCA on a case-by-case basis. For such cases, the Qualified Persons (QPs) are advised to seek BCA's comments before proceeding with the design.

2 Structural Areas Consideration

All floor areas including basement, roof, air-con ledge, staircase and suspended structural floor of open link way are to be considered, with the exception of the following:

- Driveway, apron areas and landscape areas which are not within or structurally linked to the main building.

3 Prefabricated Reinforcement Consideration

The usage of prefabricated reinforcement in cast in-situ components is based on the following:

a. Floors

Cast in-situ floor using welded wire mesh can be considered for additional points under the structural system. However, prefabricated reinforcement in precast concrete floor or in-situ concrete topping of precast concrete floor using welded wire mesh are not entitled to any points. The percentage of coverage for the use of prefabricated reinforcement in floors is based on the total area including the roof and basement, if applicable.

b. Beam Cage / Column Cage

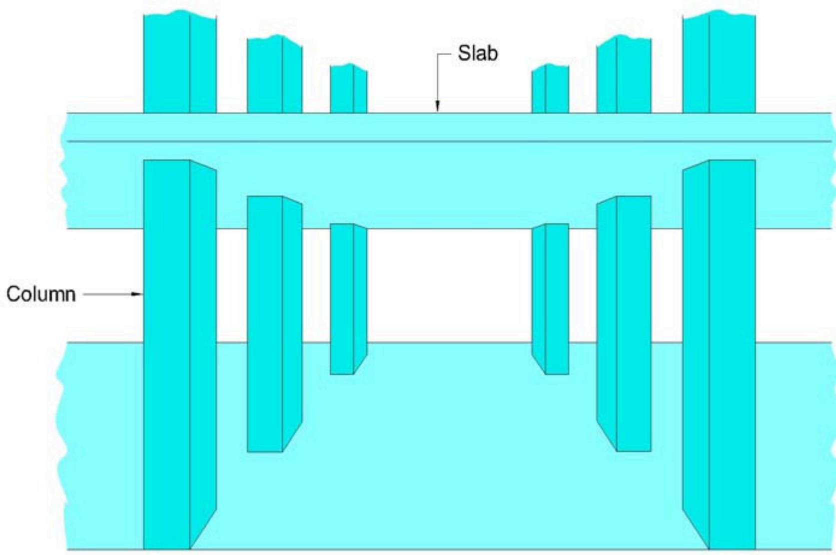
The use of prefabricated link cages in cast in-situ beams / columns which are done on site or from factory are given additional points. However, no points would be given for prefabricated link cages in precast concrete beams / columns. The percentage of coverage for the use of prefabricated cages in beams / columns is based on the total number of beams / columns which include precast and steel components.

4 Structural Systems

The interpretation of the cast in-situ systems used in Table 1 is as follows:

a. Flat Plate

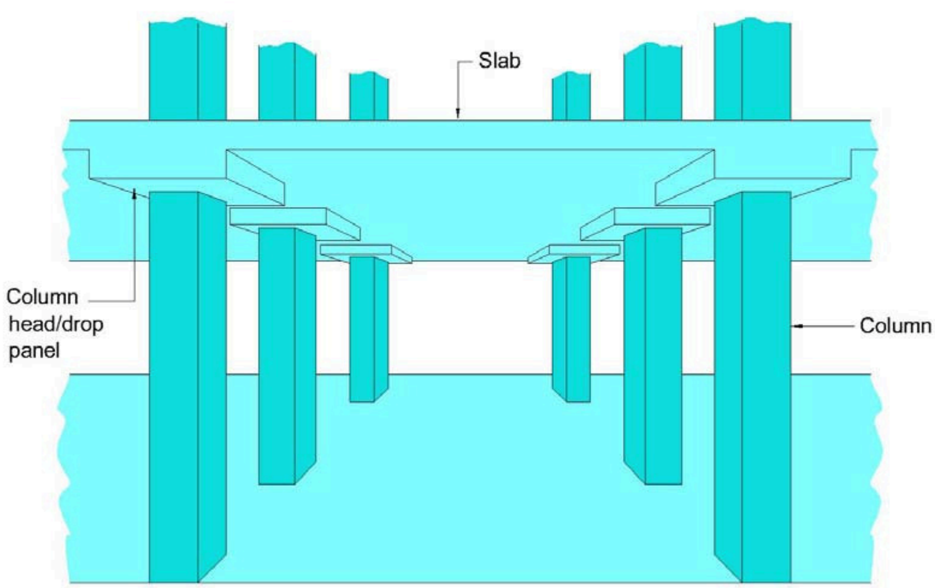
A structural floor system without column heads or drop panels (with or without perimeter beams).



Perspective View of Flat Plate

b. Flat Slab

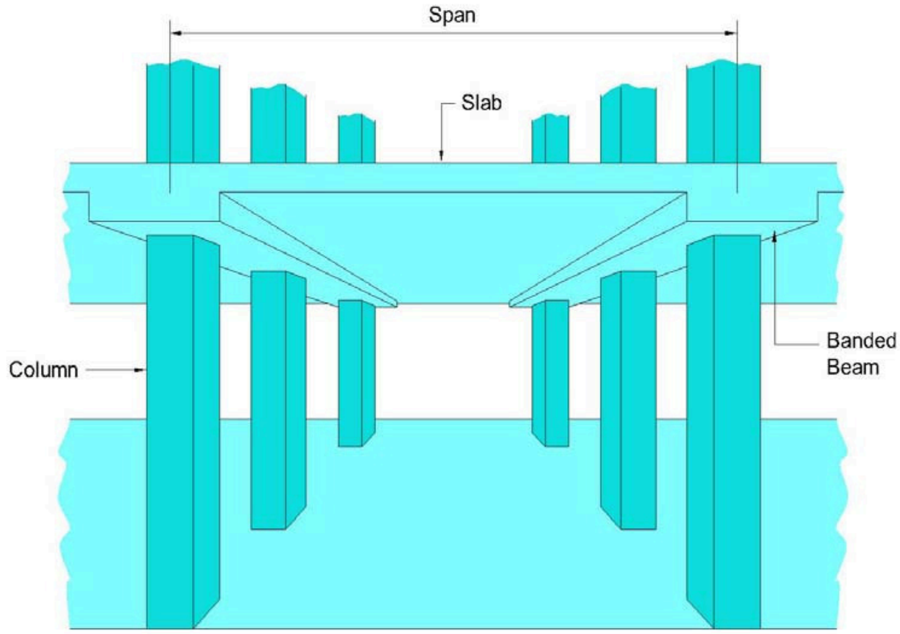
A structural floor system with column heads or drop panels (with or without perimeter beams).



Perspective View of Flat Slab

c. One-Way Banded Beam

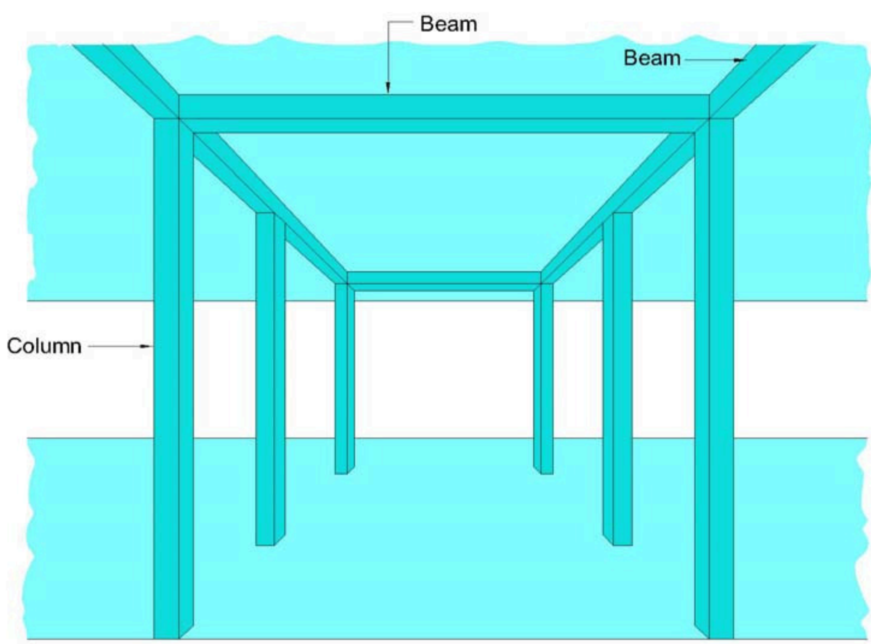
A structural beam-slab system with beams in one direction as shown.



Perspective View of Banded Beam

d. Two-Way Beam

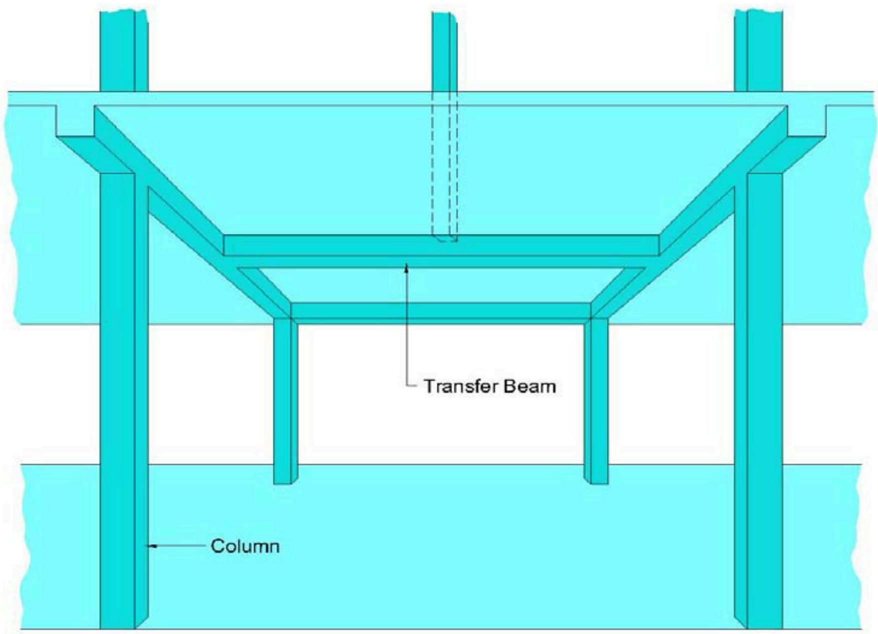
A structural beam-slab system with beams in two directions. This also applies to one way spanning slab framed by beams on all four sides.



Perspective View of 2-Way Beam

e. Cast In-situ Floor with Transfer Beam (Table 1- Note 1)

A transfer beam is a beam that interrupts the paths of load bearing elements from above and distributes the loads sideways to the ends of the beam. Cast in-situ flat plate, flat slab, one-way banded beam and two way beam are classified as cast-in-situ floor system.



Perspective View of Transfer Beam

For this system, an index of -0.10 shall be applied to the entire cast in-situ floor area including the other parts of the same floor with different cast in-situ floors which may not have any transfer beam. This requirement is applicable even if the cast in-situ floor is supported by precast column/wall.

Note : The index of -0.10 does not apply to cast in-situ floor with transfer beam designed for the purpose of ramp access.

If there are different structural floor systems within the same floor layout, the index of -0.10 shall be applied only to the entire cast in-situ floor area as illustrated below :

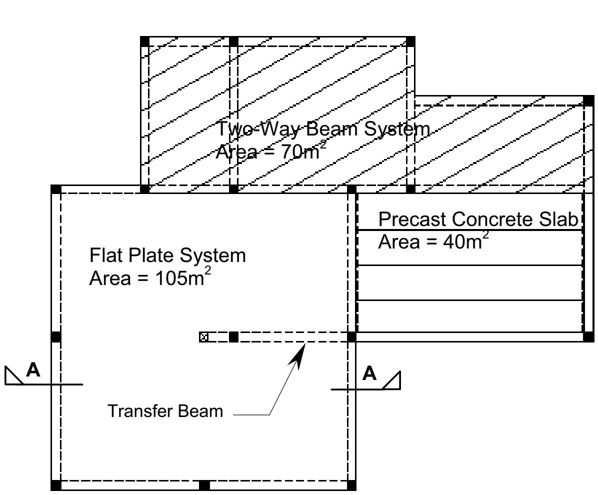
Illustration on the Application of index - 0.10 for cast in-situ floor with transfer beam

Assume that the total floor area of the whole block = 1400 m^2

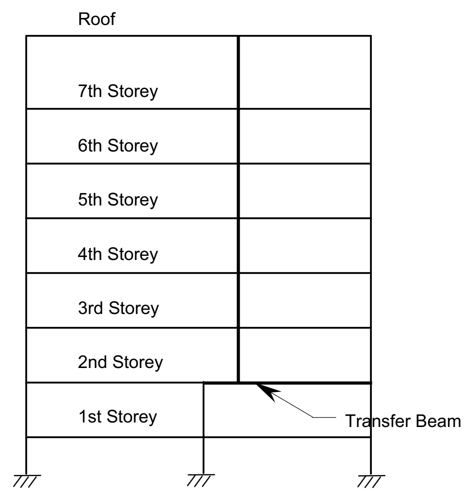
The cast in-situ floors with transfer beams adopted for the block are as follows :
(1) Flat plate system with transfer beam at 2nd storey level
(2) Two way beam-slab system with transfer beam at 7th storey level

An index of -0.10 shall be applied to the entire cast in-situ floor area for the 2nd storey level & 7th storey level.

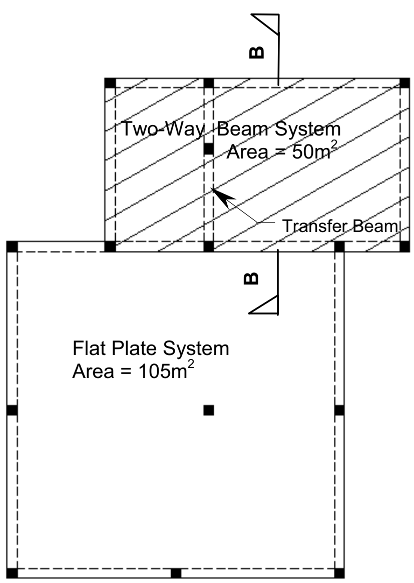
The structural floor layouts are as shown below:



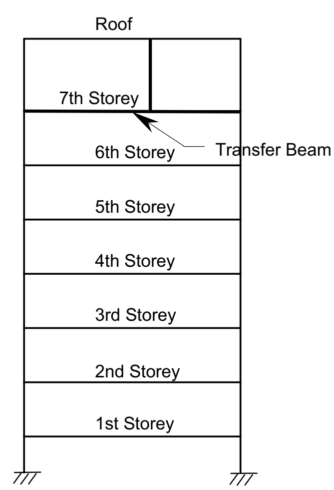
2nd Storey Plan



Schematic Section A-A



7th Storey Plan



Schematic Section B-B

Cast in-situ floor area at 2^{nd} sty level = Flat plate area + Two-way beam-slab area
= (105 + 70) = 175 m^2

Cast in-situ floor area at 7^{th} sty level = Flat plate area + Two way beam-slab area
= (105 + 50) = 155 m^2

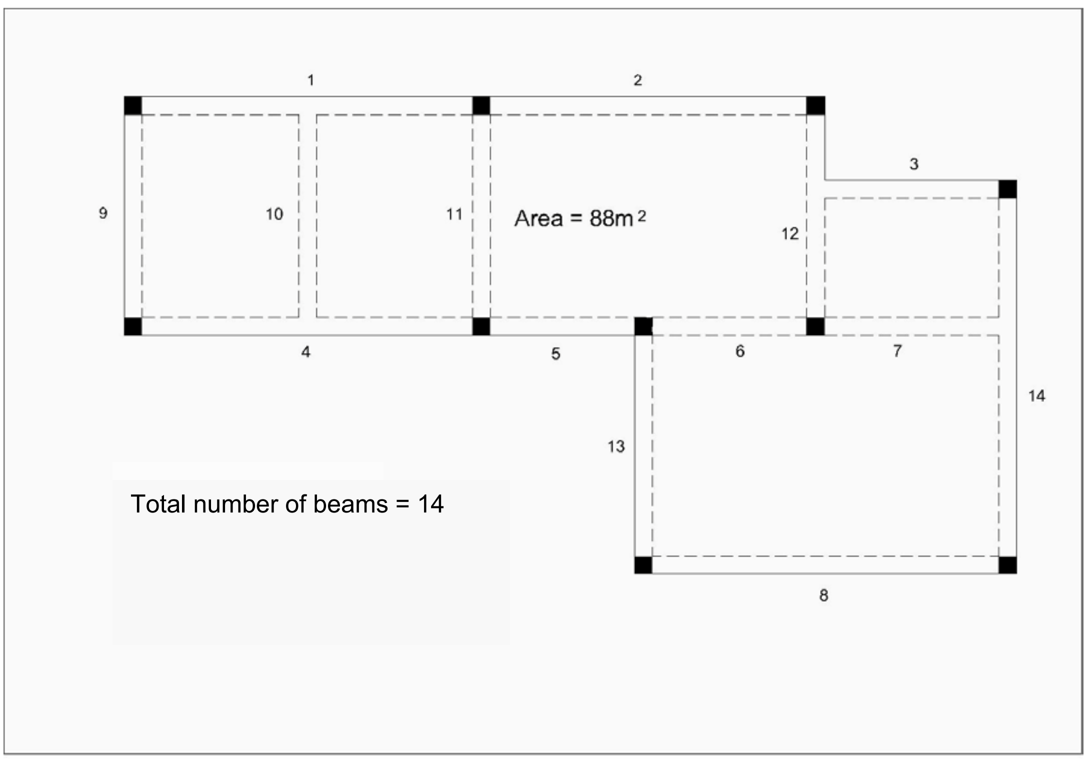
Therefore, total Cast in-situ floor area = 175 + 155 = 330 m^2

% of total floor area = 330 /1400 x 100% = 23.57 %

Negative Impact		LSI (a)	Floor Area (m^2) (b)	% of Total Floor Area (c)	Buildability Score (a)x(c)x50
2^{nd} sty	Cast in-situ floor with transfer beam (Flat plate system)	-0.10	330	23.57%	-1.18
7^{th} sty	Cast in-situ floor with transfer beam (Two-way beam system)				

f. Number of Beams

The beam between 2 supports is considered as one beam.



g. Slab/Beam (Table 1- Note 2)

The slab area over beam refers to the value of slab area over number of supporting beams. This value is required to determine the respective labour saving indices for the cast in-situ system with two-way beam.

If there are different structural systems within the same floor layout, the common beams supporting the cast in-situ system with two-way beam are to be counted for the purpose of computing the slab/beam value.

Illustration 1 – Cast in-situ slab area over beam value

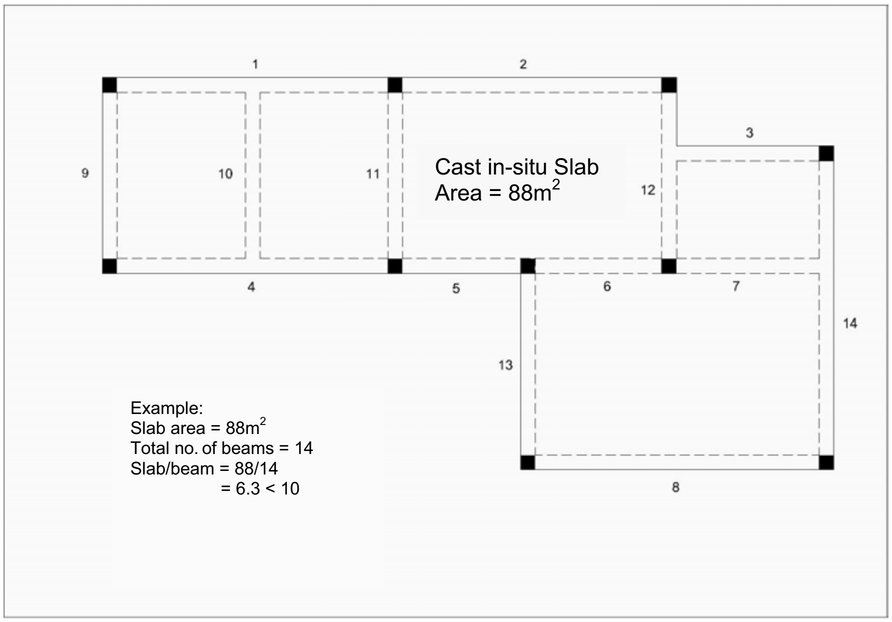
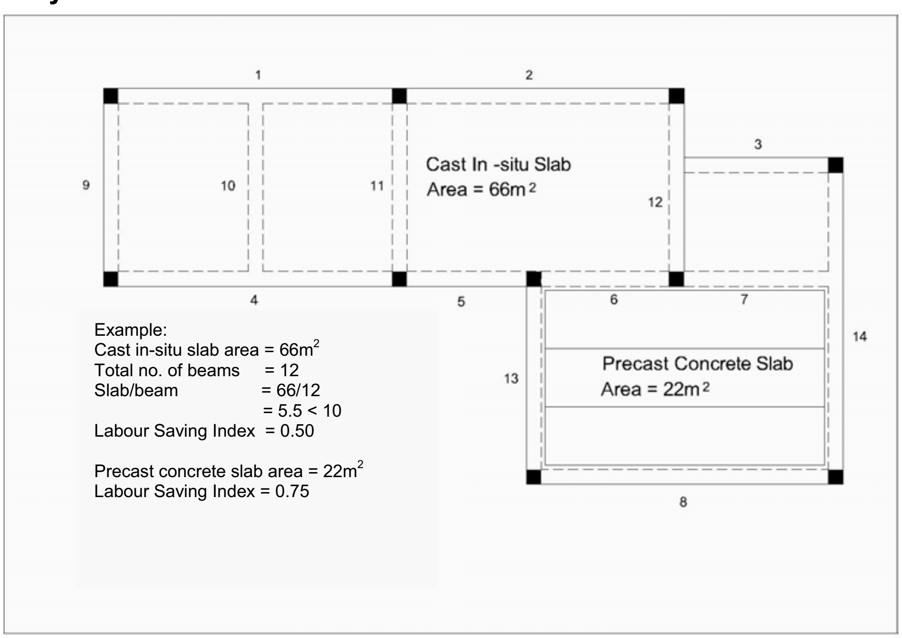


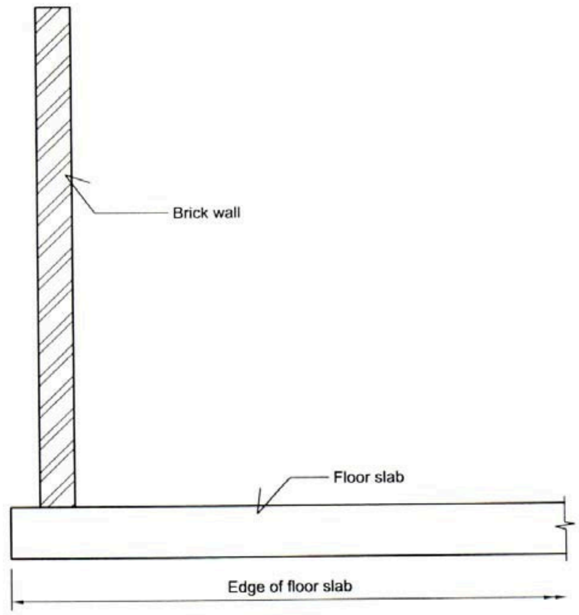
Illustration 2 – Slab/beam and LSI for cast in-situ beam/column with precast and cast in-situ slab systems



5 Measurement

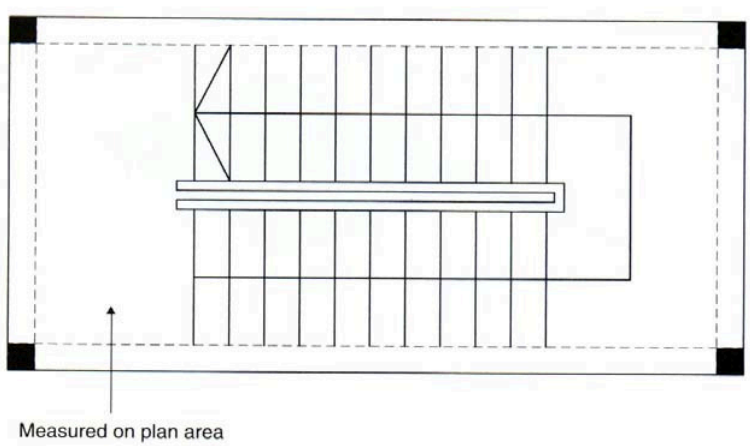
a. Floor Area

The floor area is to be measured to edge of the floor slab.



b. Staircase Area

The staircase area is to be measured on plan area.

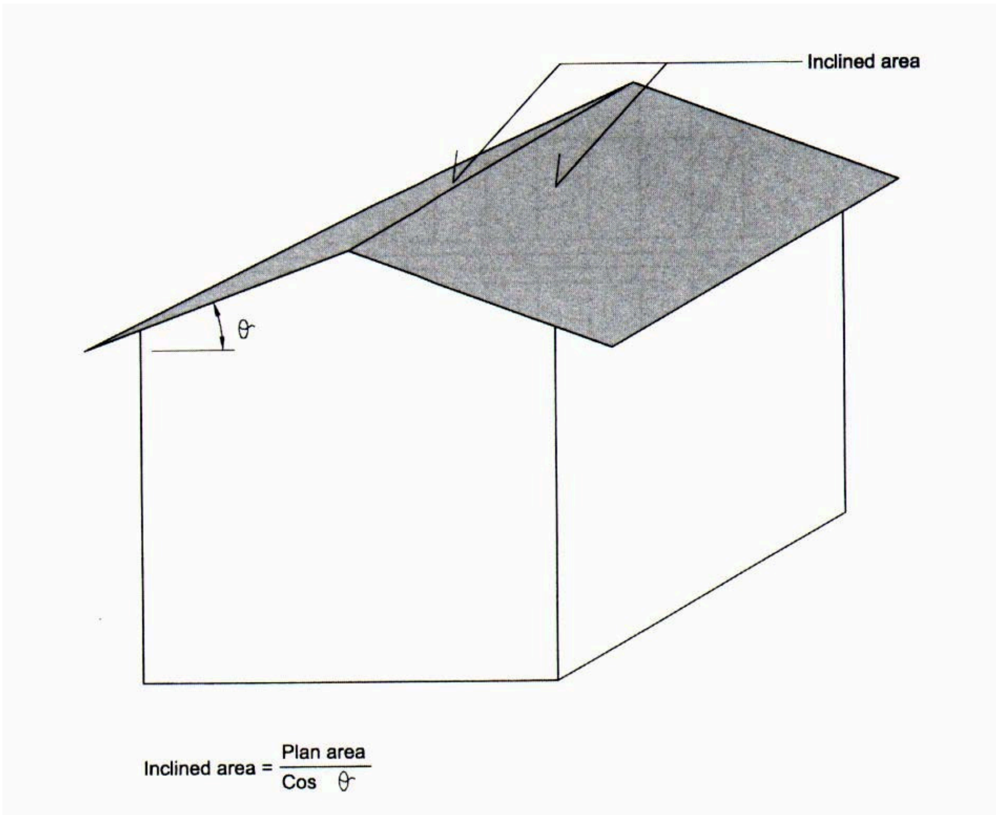


c. Flat Roof Area (≤ 7½° inclination)

The flat roof is to be measured on plan area, if the inclination is 7½° or less.

d. Pitch Roof Area (> 7½° inclination)

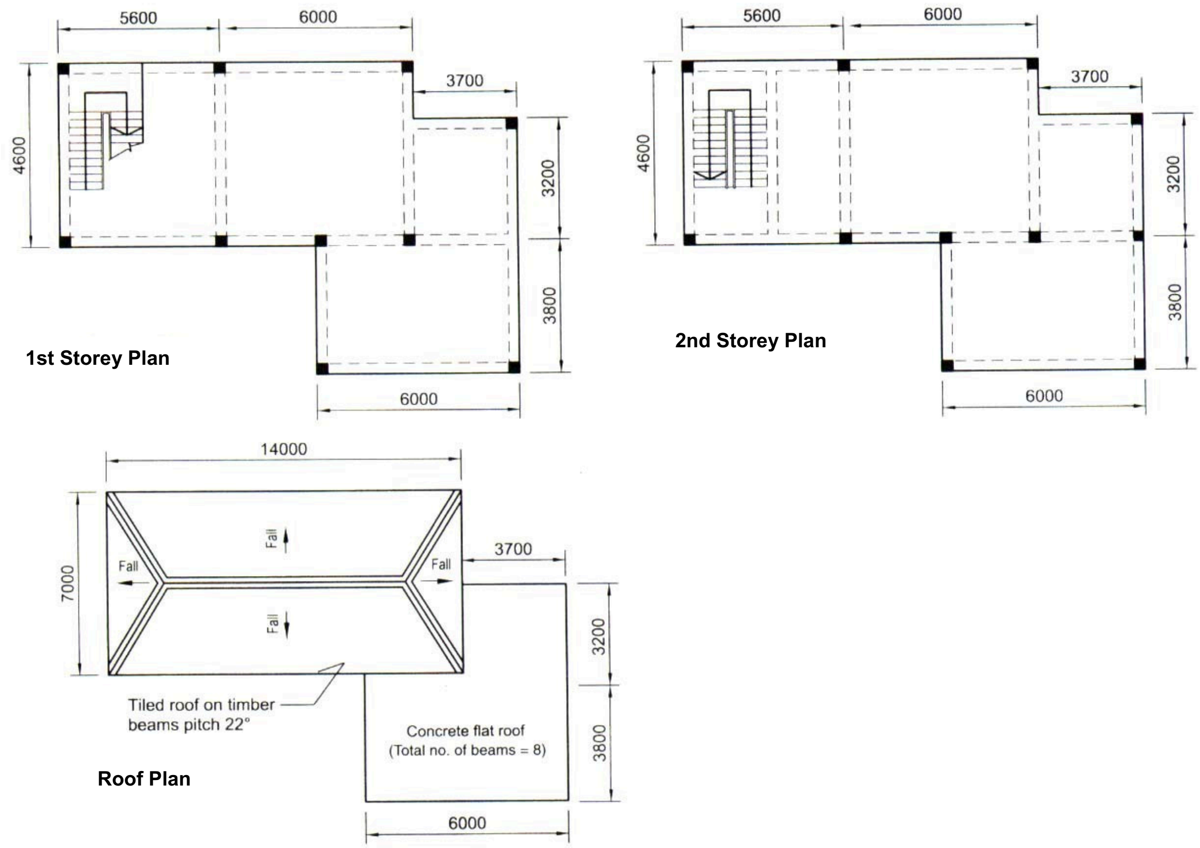
For pitch roof with an inclination of more than 7½°, the roof area is to be measured on inclined area.



Note: Other than the above-mentioned flat roof and pitch roof, please check with BCA before proceeding with the design.

6 Worked Examples

Example S1 : Computation of Buildability Score for Structural System



Step 1: Identify the structural systems used and determine the relevant labour saving index (LSI) for the particular structural system

Structural System	LSI (a)
1st storey (Cast in-situ system – Two-way beam)	0.65 or 0.50
2nd storey (Cast in-situ system – Two-way beam)	0.65 or 0.50
Roof (Cast in-situ system – Two-way beam)	0.65 or 0.50
Roof (Tiled roof on timber beam)	0.75

The LSI to be used for cast in-situ system with two-way beam would depend on the value of slab/beam

Step 2: Calculate the percentage of total floor area using a particular structural system.

Structural System	Floor Area (m^2)	% of Total Floor Area
1st storey (Cast in-situ)	(11.6 x 4.6) + (6 x 3.8) + (3.7 x3.2) = 88.00	88.00/316.34 x100% = 27.82%
2nd storey (Cast in-situ)	(11.6 x 4.6) + (6 x 3.8) + (3.7 x3.2) = 88.00	88.00/316.34 x100% = 27.82%
Roof (Cast in-situ)	(6 x 3.8) + (3.7 x3.2) = 34.64	34.64/316.34 x 100% = 10.95%
Roof (Tiled roof on timber beam)	(14 x 3.7)/ cos 22 ° = 105.70	105.70/316.34x100% = 33.41%
Total	∑(Floor Area) = 316.34	100.00%

Step 3: For cast in-situ system with two-way beam, check for value of slab/beam

1st storey slab area = 88m²

No. of beams on 1st storey slab = 13

$$\frac{\text{Slab area}}{\text{No. of beams}} = \frac{88}{13}$$

= 6.8 <10

With slab / beam ≤ 10, the relevant LSI should be 0.50

2nd storey slab area = 88m²

No. of beams on 2 nd storey slab = 14

$$\frac{\text{Slab area}}{\text{No. of beams}} = \frac{88}{14}$$

= 6.3 < 10

With slab/beam ≤ 10, the relevant LSI should be 0.50

Concrete flat roof area = 34.64m²

No. of beams on the flat roof = 8

$$\frac{\text{Slab area}}{\text{No. of beams}} = \frac{34.64}{8}$$

= 4.3 < 10

With slab/beam ≤ 10, the relevant LSI should be 0.50

Therefore, we have

Structural System	LSI (a)	Floor Area (m^2) (b)	% Area (c)
1st storey (Cast in-situ) (slab/beam ≤ 10)	0.50	88.00	27.82%
2nd storey (Cast in-situ) (slab/beam ≤ 10)	0.50	88.00	27.82%
Roof (Cast in-situ) (slab/beam ≤ 10)	0.50	34.64	10.95%
Roof (Tiled roof on timber beam)	0.75	105.70	33.41%
	Total :	316.34	100.00%

Step 4: Identify the cast in-situ floor with transfer beam and its percentage of total floor area (if any)

For cast in-situ floor with transfer beam, an index of -0.10 shall be applied to the entire cast in-situ floor area. In this example, this step is not applicable.

An index of 0.03 each would be given if prefabricated reinforcement/cage is used in cast in-situ slab, beam and column as shown in following Step 5.

Step 5: Determine the percentage of prefabricated reinforcement/cage used in cast in-situ slab, beam and column (where applicable)

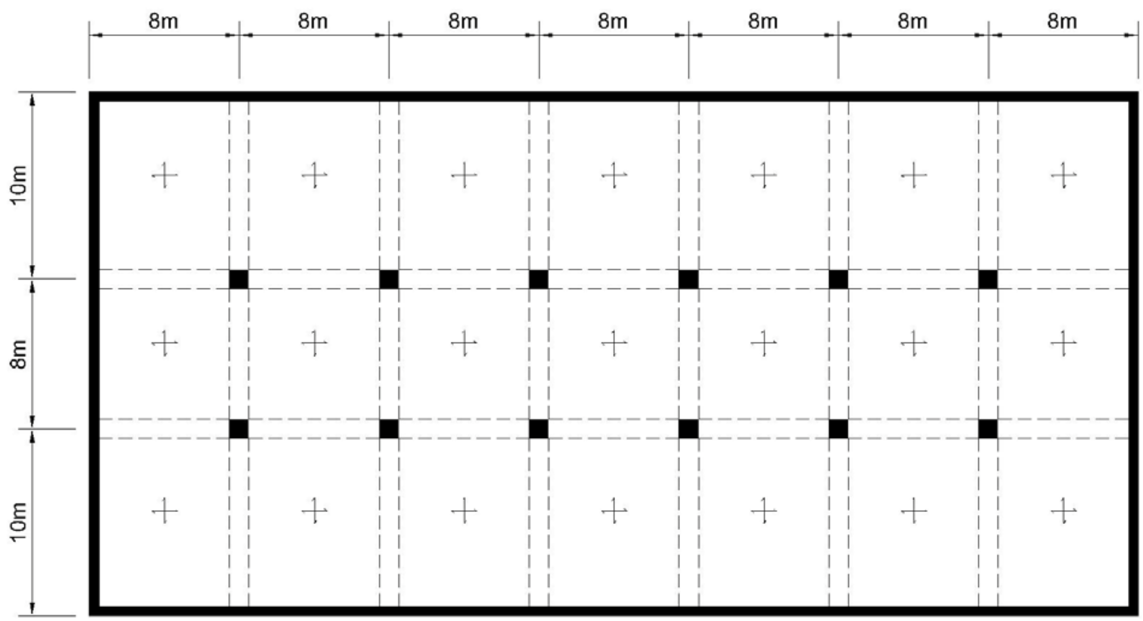
Cast in-situ System	LSI (a)	Floor Area or No. of beams/columns using prefab reinforcement /cage (b)	Total Floor Area or No. of beams /columns (b1) *see note	% Coverage (c)
1st , 2nd storey & Roof - Floor (mesh) in areas	0.03	210.64 m^2	316.34 m^2	66.59%
1st , 2nd storey & Roof - Beam Cage in nos.	0.03	27 Nos	27 Nos.	100.00%
1st , 2nd storey & Roof - Column Cage in nos.	0.03	21 Nos	21 Nos.	100.00%

Note : The total floor area refers to the total constructed floor area for the block, and includes roof (projected area) and basement area where applicable. The total number of beams/columns refers to all beams and columns used in the project including precast and steel components

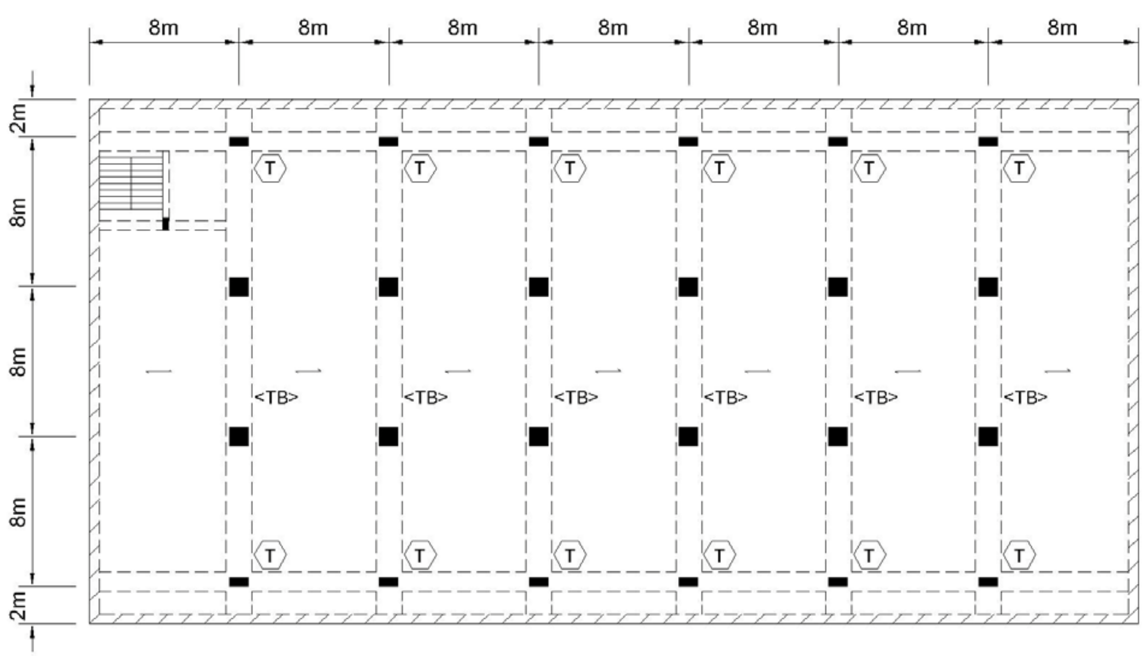
Step 6: Multiply the percentage of area / coverage by the corresponding LSI and the weight factor 50 to obtain the buildability score

Structural System	LSI (a)	Floor Area (m^2) (b)	% Area (c)	Buildability Score (a)x(c)x50
1st storey (Cast in-situ) (slab/beam ≤ 10)	0.50	88.00	27.82%	6.96
2nd storey (Cast in-situ) (slab/beam ≤ 10)	0.50	88.00	27.82%	6.96
Roof (Cast in-situ) (slab/beam ≤ 10)	0.50	34.64	10.95%	2.74
Roof (Tiled roof on timber beam)	0.75	105.70	33.41%	12.53
Sub-total for structural system (A1) :				29.19
Prefabricated reinforcement for cast in-situ components	**LSI (a)**	**% Coverage (c)**		**Buildability Score (a)x(c)x50**
1st , 2nd storey & Roof - Floor (mesh) in areas	0.03	66.59%		1.00
1st , 2nd storey & Roof – Beam Cage in nos.	0.03	100%		1.50
1st , 2nd storey & Roof – Column Cage in nos.	0.03	100%		1.50
Sub-total for using prefabricated reinforcement (A2) :				4.00
Total Buildability Score for Structural System (BS) = (A1 + A2) : (maximum 50 points)				33.19

Example S2 : Computation of Buildability Score for Structural System

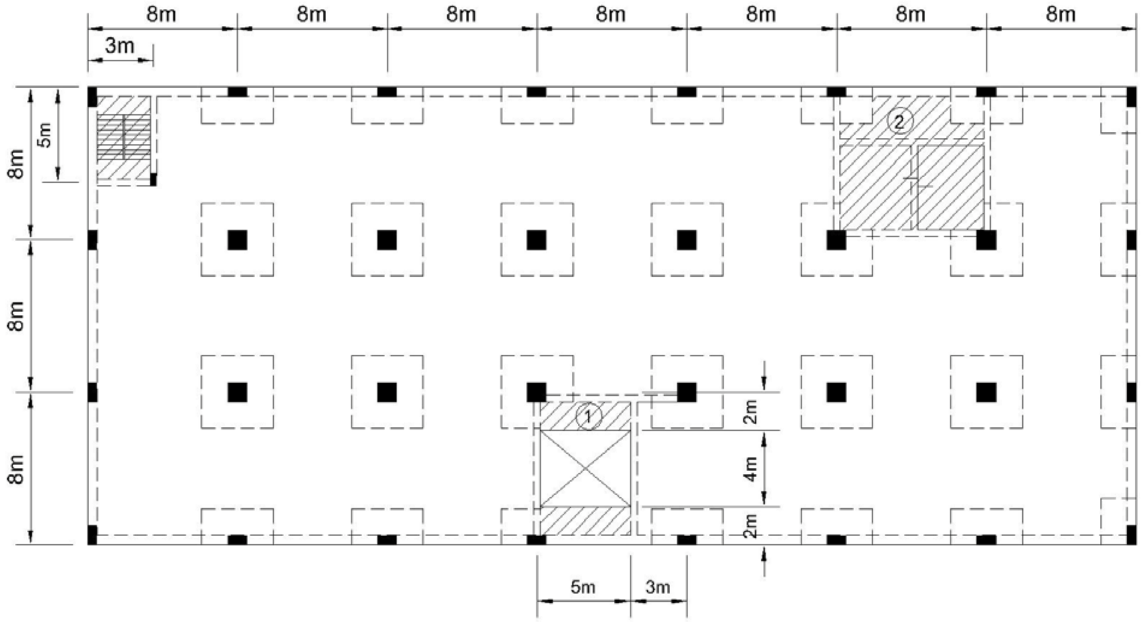


Basement Plan

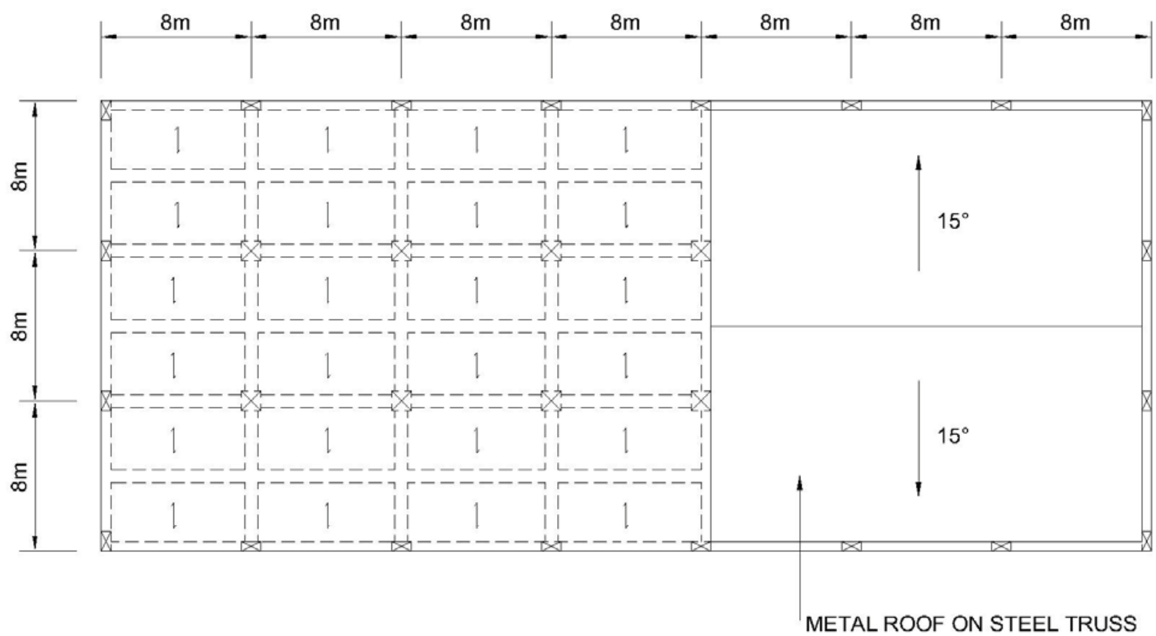


1st Storey Plan

<T> Columns taking load from 2nd storey & above
<TB>Transfer beams (one-way banded beams)



2nd & 3rd Storey Plan



Roof Plan

Step 1: Identify the structural systems used and determine the relevant labour saving index (LSI) for the particular structural system

Structural System		LSI (a)
Basement	Cast in-situ system with two-way beam	0.65 or 0.50
1^{st} storey	Cast in-situ system with one-way banded beams (& transfer beam)	0.75
2^{nd} storey & 3^{rd} storey	Flat slab	0.85
	Cast in-situ system with two-way beam (slab next to opening)	0.65 or 0.50
	Cast in-situ system with two-way beam (slab area at drop)	0.65 or 0.50
	Precast staircase	0.75
Roof	Cast in-situ system with two-way beam (roof slab)	0.65 or 0.50
	Metal roof on steel truss	0.85

The LSI to be used for cast in-situ system with two-way beam would depend on the value of slab/beam

Step 2: Calculate the percentage of total floor area using a particular structural system

Structural System		Floor Area (m^2)	% of Total Floor Area
Basement	Cast in-situ system with two-way beam	56 x 28 = 1568.00m^2	1568.00/ 7148.32 x100% = 21.94%
1^{st} storey	Cast in-situ system with one-way banded beams (& transfer beam)	56 x 28 = 1568.00m^2	1568.00/ 7148.32 x100% = 21.94%
2^{nd} storey	Flat slab	(56 x 24) – [(5 x 2)(2) + (3 x 5)+ (8 x 8) + (4 x 5)] = 1225.00m^2	1225.00/ 7148.32 x100% = 17.14%
	Cast in-situ system with two-way beam (slab next to opening)	(2 x 5) + (2 x 5) = 20.00m^2	20.00/ 7148.32 x 100% = 0.28%
	Cast in-situ slab with two-way beam (slab area at drop)	8 x 8 = 64.00m^2	64.00/ 7148.32 x 100% = 0.89%
	Precast staircase	3 x 5 = 15.00m^2	15.00/ 7148.32 x 100% = 0.21%
3^{rd} storey	Flat slab	(56 x 24) – [(5 x 2)(2) + (3 x 5)+ (8 x 8) + (4 x 5)] = 1225.00m^2	1225.00/ 7148.32 x 100% = 17.14%
	Cast in-situ system with two-way beam (slab next to opening)	(2 x 5) + (2 x 5) = 20.00m^2	20.00/ 7148.32 x 100% = 0.28%
	Cast in situ system with two-way beam (slab area at drop)	8 x 8 = 64.00m^2	64.00/ 7148.32 x 100% = 0.89%
	Precast staircase	3 x 5 = 15.00m^2	15.00/ 7148.32 x 100% = 0.21%
Roof	Cast in-situ system with two-way beam (roof slab)	32 x 24 = 768.00m^2	768.00/ 7148.32 x 100% = 10.74%
	Metal roof on steel truss	[(12 x 24) + (12 x 24)]/cos 15° = 596.32m^2	596.32/ 7148.32 x 100% = 8.34%
	Total :	$\sum$ (Floor Area) = 7148.32m^2	100.00%

Step 3: For cast in-situ system with two-way beam, check for value of slab/beam

Basement

Slab area = 1568m^2

No. of beams on basement slab = 32

$$\frac{\text{Slab area}}{\text{No. of beams}} = \frac{1568}{32}$$

$$= 49 > 10$$

With slab / beam > 10, the relevant LSI should be 0.65

2nd Storey (3rd Storey Similar)

(i) Slab area 1 = 20 m^2
(next to opening)

No. of beams on slab area 1 = 4

$$\frac{\text{Slab area}}{\text{No. of beams}} = \frac{20}{4}$$

$$= 5 < 10$$

With slab / beam ≤ 10, the relevant LSI should be 0.50

(ii) Slab area 2 = 64 m^2
(at drop area)

No. of beams on slab area 2 = 6

$$\frac{\text{Slab area}}{\text{No. of beams}} = \frac{64}{6}$$

$$= 10.67 > 10$$

With slab / beam > 10, the relevant LSI should be 0.65

Roof

(i) Concrete flat roof area = 768 m^2

No. of beams on concrete flat roof area = 43

$$\frac{\text{Slab area}}{\text{No. of beams}} = \frac{768}{43}$$

$$= 17.86 > 10$$

With slab / beam > 10, the relevant LSI should be 0.65

Therefore, we have

Structural System		LSI (a)	Floor Area (m^2) (b)	% Area (c)
Basement	Cast in-situ system with two-way beam	0.65	1568.00	21.94%
1st storey	Cast in-situ system with one-way banded beams (& transfer beam)	0.75	1568.00	21.94%
2nd storey	Flat slab	0.85	1225.00	17.14%
	Cast in-situ system with two-way beam (slab next to opening)	0.50	20.00	0.28%
	Cast in-situ slab with two-way beam (slab area at drop)	0.65	64.00	0.89%
	Precast staircase	0.75	15.00	0.21%
3rd storey	Flat slab	0.85	1225.00	17.14%
	Cast in-situ system with two-way beam (slab next to opening)	0.50	20.00	0.28%
	Cast in-situ system with two-way beam (slab area at drop)	0.65	64.00	0.89%
	Precast staircase	0.75	15.00	0.21%
Roof	Cast in-situ system with two-way beam (roof slab)	0.65	768.00	10.74%
	Metal roof on steel truss	0.85	596.32	8.34%
		Total :	7148.32	100.00%

An index of -0.10 shall be applied to the entire cast in-situ floor area as shown in the following Step 4.

Step 4: Identify the cast in-situ floor with transfer beam and its percentage of total floor area (if any)

Negative Impact		LSI (a)	Floor Area (m^2) (b)	% Area (c)
1st storey	Cast in-situ system with transfer beam (one-way banded beam)	-0.10	1568.00	21.94%

An index of 0.03 each would be given if prefabricated reinforcement/cage is used in cast in-situ slab, beam and column as shown in following Step 5.

Step 5: Determine the percentage of prefabricated reinforcement/cage used in cast in-situ slab, beam and column (where applicable)

Cast in-situ System	LSI (a)	Floor Area or No. of beams/columns using prefab reinforcement /cage (b)	Total Floor Area or No. of beams /columns (b1)*see note	% Coverage (c)
1st, 2nd & 3rd storey & Roof – Floor (mesh) in areas	0.03	2450.00 m^2	7148.32 m^2	34.27%
1st, 2nd & 3rd storey & Roof – Beam Cage in nos.	0.03	105 nos.	169 nos.	62.13%
1st, 2nd & 3rd storey & Roof – Column Cage in nos.	0.03	103 nos.	103 nos.	100.00%

Note : The total floor area refers to the total constructed floor area for the block, and includes roof (projected area) and basement area where applicable. The total number of beams/columns refers to all beams and columns used in the project including precast and steel components

Step 6: Multiply the percentage of coverage by the corresponding LSI and the weight factor 50 to obtain the buildability score

Structural System		LSI (a)	Floor Area (m^2) (b)	% Area (c)	Buildability Score (a)x(c)x50
Basement	Cast in-situ system with two-way beam	0.65	1568.00	21.94%	7.13
1st storey	Cast in-situ system with one-way banded beams (& transfer beam)	0.75	1568.00	21.94%	8.23
2nd storey	Flat slab	0.85	1225.00	17.14%	7.29
	Cast in-situ system with two-way beam (slab next to opening)	0.50	20.00	0.28%	0.07
	Cast in-situ slab with two-way beam (slab area at drop)	0.65	64.00	0.89%	0.29
	Precast staircase	0.75	15.00	0.21%	0.08
3rd storey	Flat slab	0.85	1225.00	17.14%	7.29
	Cast in-situ system with two-way beam (slab next to opening)	0.50	20.00	0.28%	0.07
	Cast in-situ system with two-way beam (slab area at drop)	0.65	64.00	0.89%	0.29
	Precast staircase	0.75	15.00	0.21%	0.08
Roof	Cast in-situ system with two-way beam (roof slab)	0.65	768.00	10.74%	3.49
	Metal roof on steel truss	0.85	596.32	8.34%	3.54
				Sub-total for structural system (A1) :	37.85

Negative Impact		LSI (a)	Floor Area (m^2) (b)	% Area (c)	Buildability Score (a)x(c)x50
1st storey	Cast in-situ system with transfer beam (one-way banded beam)	-0.10	1568.00	21.94%	-1.10
				Sub-total for negative impact (A2) :	-1.10

Prefabricated reinforcement for cast in-situ components	LSI (a)	% Coverage (c)	Buildability Score (a)x(c)x50
1st , 2nd & 3rd storey & Roof – Floor (mesh) in areas	0.03	34.27%	0.51
1st , 2nd & 3rd storey & Roof –Beam Cage in nos.	0.03	62.13%	0.93
1st , 2nd & 3rd storey & Roof –Column Cage in nos.	0.03	100.00%	1.50
		Sub-total for the use of prefabricated reinforcement (A3) :	2.94
		Total Buildability Score for Structural System (BS) = (A1 + A2 +A3) : (maximum 50 points)	39.69

Part 2 Wall Systems

- ❖ Labour Saving Indices for Different Wall Systems
- ❖ Wall Length Consideration
- ❖ Prefabricated Reinforcement Consideration
- ❖ Measurement
- ❖ Worked Examples

Part 2 Wall Systems

1 Labour Saving Indices for Different Wall Systems

The labour saving index derived for each wall system is as shown in the following Table 2.

Table 2 Wall System - Sw Value

WALL SYSTEM	LABOUR SAVING INDEX S_W	
Curtain wall/full height glass partition/dry partition wall[2] /prefabricated railing	0.70	1.00[1]
Precast concrete panel/wall[3]	0.80	0.90[1]
PC formwork[4]	0.50	0.75[1]
Cast in-situ RC wall	0.50	0.70[1]
Cast in-situ RC wall with prefabricated reinforcement	0.54	0.74[1]
Precision block wall (internal wall)	0.40	0.45[1]
Precision block wall (external wall)	0.30	
Brickwall	0.30	

NOTE:

(1) The higher indices apply to no finishes, finishes done off-site or where skim coat and/or paint is applied on site.

(2) Dry partition walls include sandwich panel wall systems, stud and sheet partition wall systems, demountable wall systems.

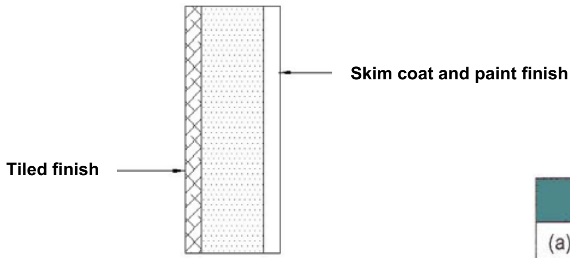
(3) Precast concrete panels/walls include normal weight concrete panels, lightweight concrete panels, autoclaved aerated concrete panels.

(4) PC formwork refer to precast formwork panel with concrete infill.

Indices for other systems that are not shown in this table shall be determined by BCA on a case-by-case basis. For such cases, the Qualified Persons (QPs) are advised to seek BCA's comments before proceeding with the design.

The relevant labour saving indices to be adopted in buildability score computation for wall system depend on (a) types of wall system and (b) wall finishes used. Where there is a combination of wall systems and/or wall finishes, the lowest labour saving index should be adopted for the entire wall length as shown in the following illustrations:

Illustration 1 - Same wall system with different finishes

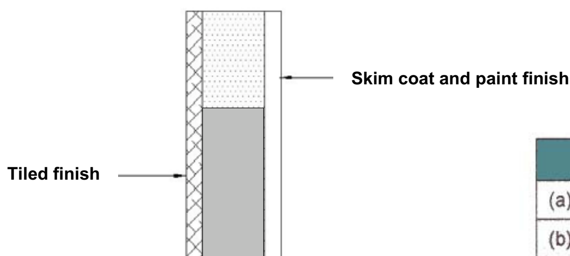


Sectional View of Precision Block Wall

Wall System	Labour Saving Index
(a) Precision block with skim coat & paint finish	0.45
(b) Precision block with tiled finish	0.40

Labour saving index = 0.40 (based on lowest labour saving index for the entire wall)

Illustration 2 - Different wall systems with different finishes

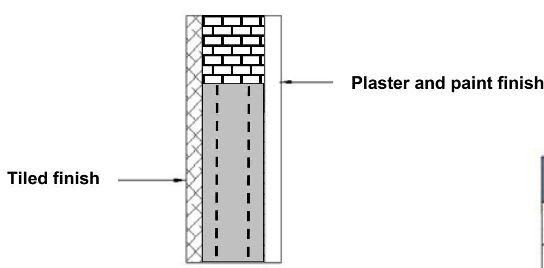


Sectional View of Precision Block Wall with Cast in-situ Wall

Wall System	Labour Saving Index
(a) Precision block with skim coat & paint finish	0.45
(b) Precision block with tiled finish	0.40
(c) Cast in-situ wall with skim coat & paint finish	0.70
(d) Cast in-situ wall with tiled finish	0.50

Labour saving index = 0.40 (based on lowest labour saving index for the entire wall)

Illustration 3 - Different wall systems with different finishes



Sectional View of Brickwall with Cast in-situ Wall (with prefab reinforcement)

Wall System	Labour Saving Index
(a) Brickwall with plaster and paint finish	0.30
(b) Cast in-situ wall with plaster and paint finish OR with tiled finish (Use of Prefab Reinforcement)	0.54

Labour saving index = 0.30 (based on lowest labour saving index for the entire wall)

2 Wall Length Consideration

Generally, the buildability score computation for wall system includes all wall lengths, with some exceptional cases as listed below.

Include

- External and internal walls
- Full height windows and doors
- Lining walls to external basement wall
- Parapet walls

Exclude

- External basement wall
- Hand-rails mounted on staircases and parapet walls
- Toilet cubicle walls and doors
- Sun-shades or any sun-shading devices
- "Collapsible" wall that divides rooms
- Vertical barrier at air-con ledges

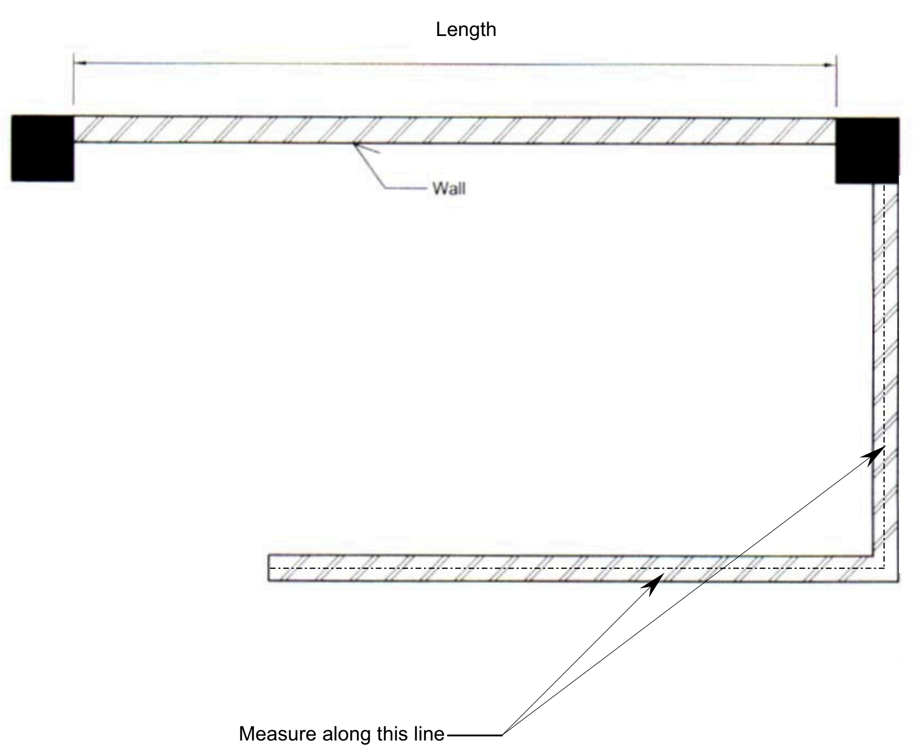
3 Prefabricated Reinforcement Consideration

The labour saving indices given to cast in-situ RC wall with prefabricated reinforcement in Table 2 only apply to RC wall that uses welded wire mesh from factory. The indices cannot apply to RC wall with prefabricated reinforcement tied on site and prefabricated reinforcement in precast concrete panel/wall.

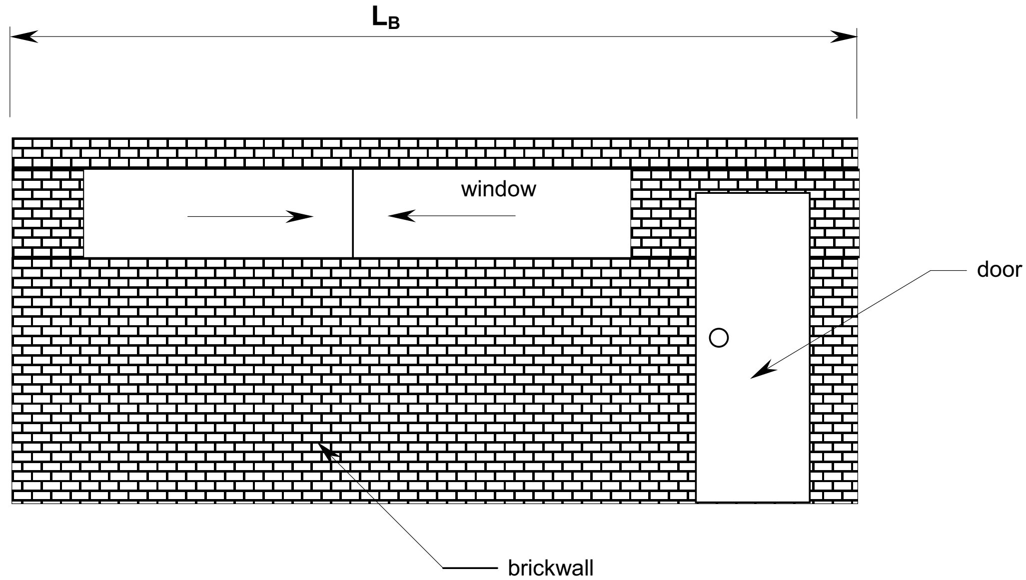
4 Measurement

a. Wall Length

The length of the wall is to be measured along its centre line as follows:



In the case where there are windows and doors, the wall length is measured on plan accordingly. Doors and windows are measured as part of wall systems as illustrated below :



Buildability Score $_{\text{Wall System}}$ = 40 [$\sum$ (% of total wall length of the building using a particular wall system x respective labour saving index for wall system (Table 2))]

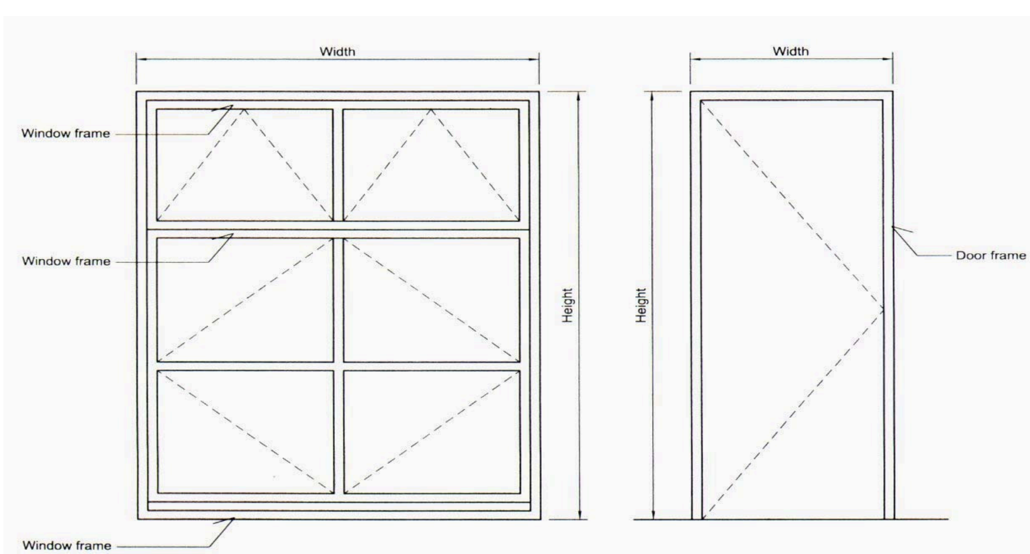
Assume total wall length for the whole block to be L_T

Buildability score $_{\text{Brickwall}}$ = $40_{(\text{weightage})} \times [L_B / L_T \times LSI_{(\text{brick})}]$

Note: If full height windows & doors are used, the labour saving index of 1.00 can be applied for the subjected window & door length.

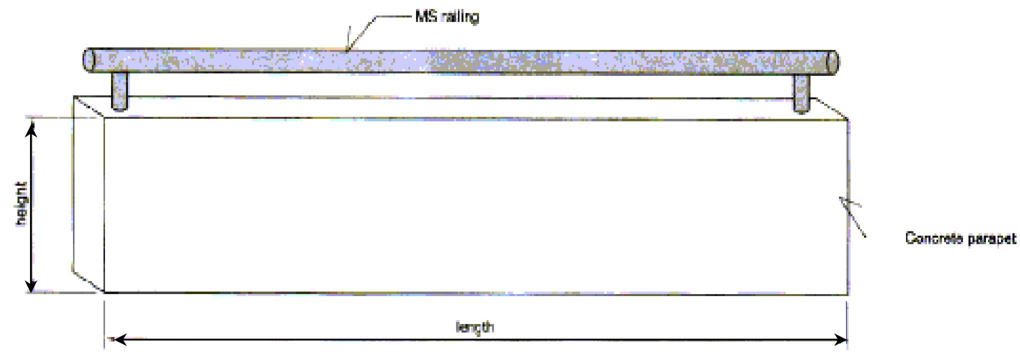
b. Full Height Windows & Doors

Length of windows and doors could be separately considered in wall measurement if they are full height. Labour saving Index of 1.00 could be applied for the length of full height window, door and sliding door used. The lengths measured (i.e. the width of windows or doors) are inclusive of frame.

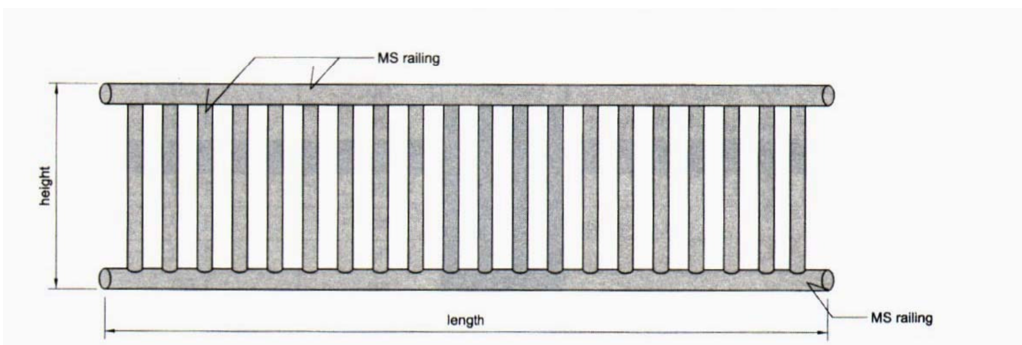


c. Parapet Wall

Only the length of the parapet wall is to be considered in computation.



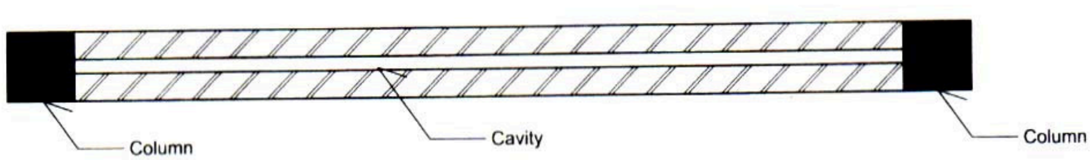
In the case of a parapet wall consisting of mild steel (MS) railing, the length of the wall should be considered as shown in the illustration below.



Note : Labour saving index for MS railing = 1.00

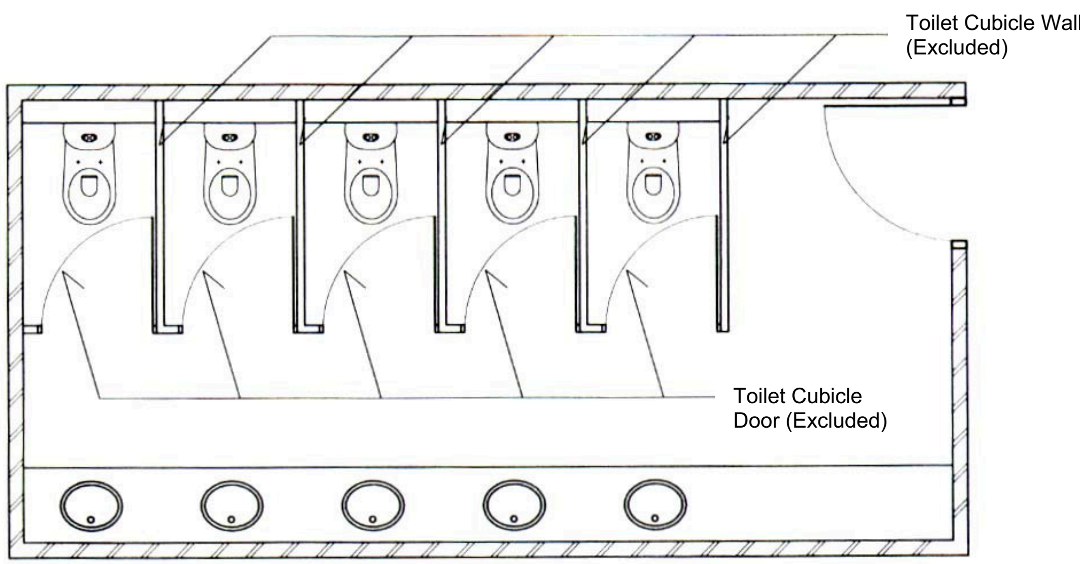
d. Cavity Walls

Cavity walls are considered as 2 separate walls. Therefore, the wall lengths are to be measured twice.



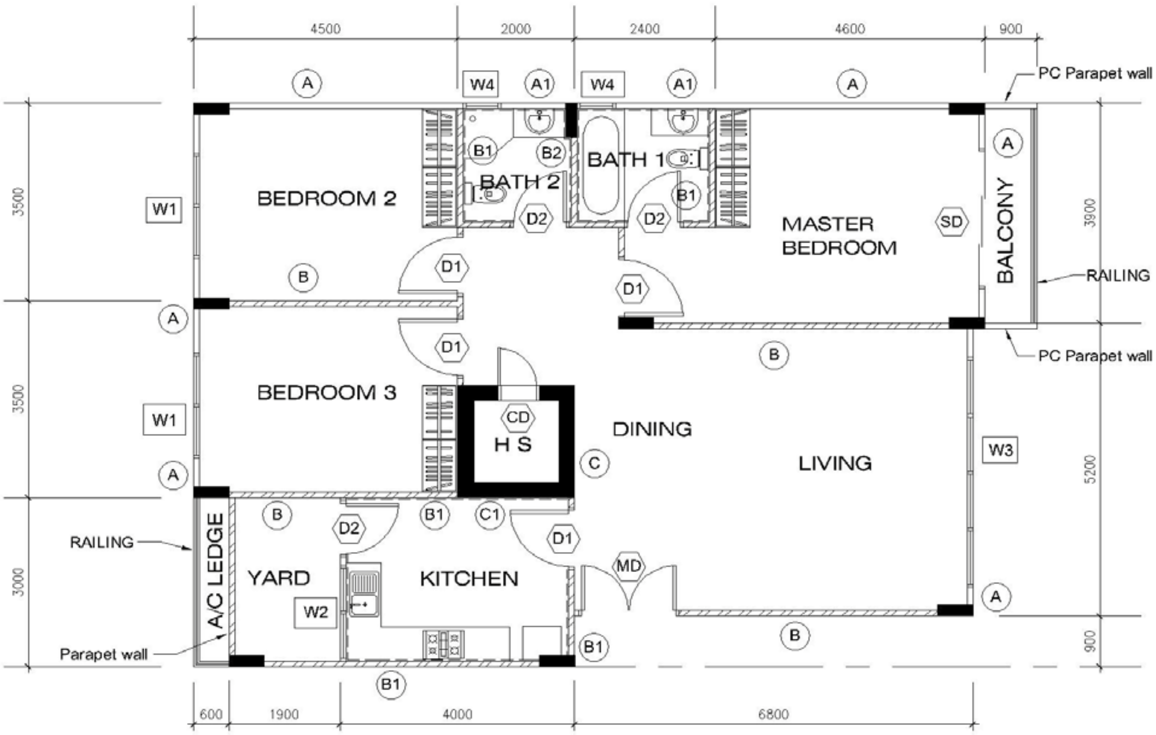
e. Toilet Cubicle Walls and Doors

Toilet cubicle walls and doors are to be excluded from computation of wall lengths.



5 Worked Examples

Example W1 – Computation of Buildability Score for Wall System



Typical Floor Plan

Step 1: Identify the wall system and finishes used and determine the relevant labour saving index (LSI) for the particular wall system

Type	Wall System	Wall finishes	LSI (c)
A	PC wall with skim coat & paint finish on both sides	Skim & paint	0.90
A1	PC wall with tiled finish (installed at site) on one side and skim coat & paint finish on the other side	Tiled finish	0.80*
		Skim & paint	0.90
B	Brickwall with plaster & paint finish on both sides	Plaster & paint finish	0.30
B1	Brickwall with tiled finish on one side & plaster & paint finish on the other side	Tiled finish	0.30
		Plaster & paint	0.30
B2	Brickwall with tiled finish on both sides	Tiled finish	0.30
C	RC wall (for HS) with paint finish on one side and plaster & paint finish on the other side	Paint finish	0.70
		Plaster & paint	0.50*
C1	RC wall (for HS) with paint finish on one side and tiled finish on the other side	Paint finish	0.70
		Tiled finish	0.50*
	Railing	-	1.00
	Full height sliding door	-	1.00

Note: * denotes Lowest LSI to be adopted

Step 2: Calculate the wall length (include doors and windows) and the percentage of total wall length using a particular wall system

Type	Wall System	Length (m) (a)	% of Total Length (b)
A	PC wall with skim coat & paint finish on both sides	21.90	25.31%
A1	PC wall with tiled finish on one side and skim coat & paint finish on the other side	4.20	4.85%
B	Brickwall with plaster & paint finish on both sides	24.20	27.97%
B1	Brickwall with tiled finish on one side & plaster & paint finish on the other side	20.46	23.65%
B2	Brickwall with tiled finish on both sides	1.39	1.61%
C	RC wall (for HS) with paint finish on one side and plaster & paint finish on the other side	5.93	6.85%
C1	RC wall (for HS) with paint finish on one side and tiled finish on the other side	1.98	2.29%
	Railing	3.75	4.33%
	Full height sliding door	2.70	3.12%
	Total :	86.51	100.00%

Note :

(1) Length of walls is measured from plans.

(2) Railing for air-con ledge is to be excluded in computation.

Step 3: Multiply the percentage of wall length by the corresponding LSI and the weight factor 40 to obtain the buildability score

Type	Wall System	Length (m) (a)	% of Total Length (b)	LSI (c)	Buildability Score (d) = (b)x(c)x40
A	PC wall with skim coat & paint finish on both sides	21.90	25.31%	0.90	9.11
A1	PC wall with tiled finish on one side and skim coat & paint finish on the other side	4.20	4.85%	0.80	1.55
B	Brickwall with plaster & paint finish on both sides	24.20	27.97%	0.30	3.36
B1	Brickwall with tiled finish on one side & plaster & paint finish on the other side	20.46	23.65%	0.30	2.84
B2	Brickwall with tiled finish on both sides	1.39	1.61%	0.30	0.19
C	RC wall (for HS) with paint finish on one side and plaster & paint finish on the other side	5.93	6.85%	0.50	1.37
C1	RC wall (for HS) with paint finish on one side and tiled finish on the other side	1.98	2.29%	0.50	0.46
	Railing	3.75	4.33%	1.00	1.73
	Full height sliding door	2.70	3.12%	1.00	1.25
				Buildability Score for Wall System : (Maximum 40 points)	21.87

Note: The above example consists of only one apartment with different wall types for illustration purpose.

Part 3 Other Buildable Design Features

Points Awarded for Other Buildable Design Features

❖ Standardisation

- Columns
- Beams
- Door Leaf Openings
- Windows

❖ Grids

- Repetition of Floor to Floor Height
- Vertical Repetition of Structural Floor Layout

❖ Others

- Multi-tier Precast Columns
- Precast or Pre-assembled/Metal Staircases
- Precast Meter Chambers
- Precast Refuse Chutes
- Precast Service Risers
- Non-screed Floor
- Columns Sit Directly on Top of Piles
- Ground Beams on Top of Pilecaps And/Or Integrated with Pilecaps

❖ Single Integrated Components (Bonus Points)

- Prefabricated Bathroom/Toilet Units complete with piping/wiring
- Precast Household Shelters

❖ Demerit Points

- Non-functional Void on Slab

Points awarded for Other Buildable Design Features

The points given to each buildable design feature is as shown in Table 3.

Table 3 Other Buildable Design Features - N Value

BUILDABLE FEATURES		MODULE	UNIT OF COVERAGE	N VALUE	
				PERCENTAGE OF COVERAGE[4]	
				≥65% to < 80%	≥ 80%
1. Standardisation					
1.1	Columns (3 most common sizes)	0.5M[2]	no.		2.00
1.2	Beams (3 most common sizes)	0.5M[2]	no.		2.00
1.3	Door leaf openings (width) (3 most common sizes)	0.5M	no.		1.00
1.4	Windows (3 most common sizes)[1]	1M/1M[3]	no.		1.00
2. Grids					
2.1(a)	Repetition of floor-to-floor height For blocks more than 6 storey *The repetition should omit bottom floor, top floor and above.*	0.5M	no.	1.50	2.00
2.1(b)	Repetition of floor-to-floor height For blocks up to 6 storey *The repetition should omit bottom floor, top floor and above. Only applicable if there are at least 2 floors remaining after the floor omission.*	0.5M	no.	0.75	1.00
2.2(a)	Vertical repetition of structural floor layout For blocks more than 6 storey *The repetition should omit bottom floor, top floor and above.*		area	1.50	2.00
2.2(b)	Vertical repetition of structural floor layout For blocks up to 6 storey *The repetition should omit bottom floor, top floor and above. Only applicable if there are at least 2 floors remaining after the floor omission.*		area	0.75	1.00
3. Others					
3.1	Multi-tier precast columns		no.		2.00
3.2	Precast or pre-assembled/ metal staircases		no.		2.00
3.3	Precast meter chambers		no.		1.50
3.4	Precast refuse chutes		no.		1.50
3.5	Precast service risers		no.		1.00
3.6	Non-screed floor		area		1.00
3.7	Columns sit directly on top of piles		no.		1.00
3.8	Ground beams on top of pilecaps and/or integrated with pilecaps		no.		1.00
A. Single Integrated Components (Bonus Points)					
A.1	Prefabricated bathroom/toilet units complete with piping/wiring		no.	2.00	3.00
A.2	Precast household shelters *Household shelter is considered as precast if the total length of the in-situ joints is not more than 20% of its wall perimeter on plan.*		no.	2.00	3.00

NOTE:

(1) Sizes based on dimensions of frames.

(2) The module of 0.5M does not apply to steel columns and beams.

(3) 1M for width and 1M for height (1M = 100 mm).

(4) Percentage of coverage is to be based on total floor area or on total number of components such as columns, beams, doors, windows etc.

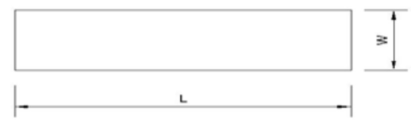
* For void on slab that does not serve any functional requirement and is enclosed by walls, 1.00 point will be deducted even if there is only one such void within a block.

1 Standardisation

1.1 Columns (3 most common sizes)

All structural columns should be accounted for. Stumps at foundation level need not be considered. The sectional length (L) of the concrete column is to be equal or less than four times its width (W).

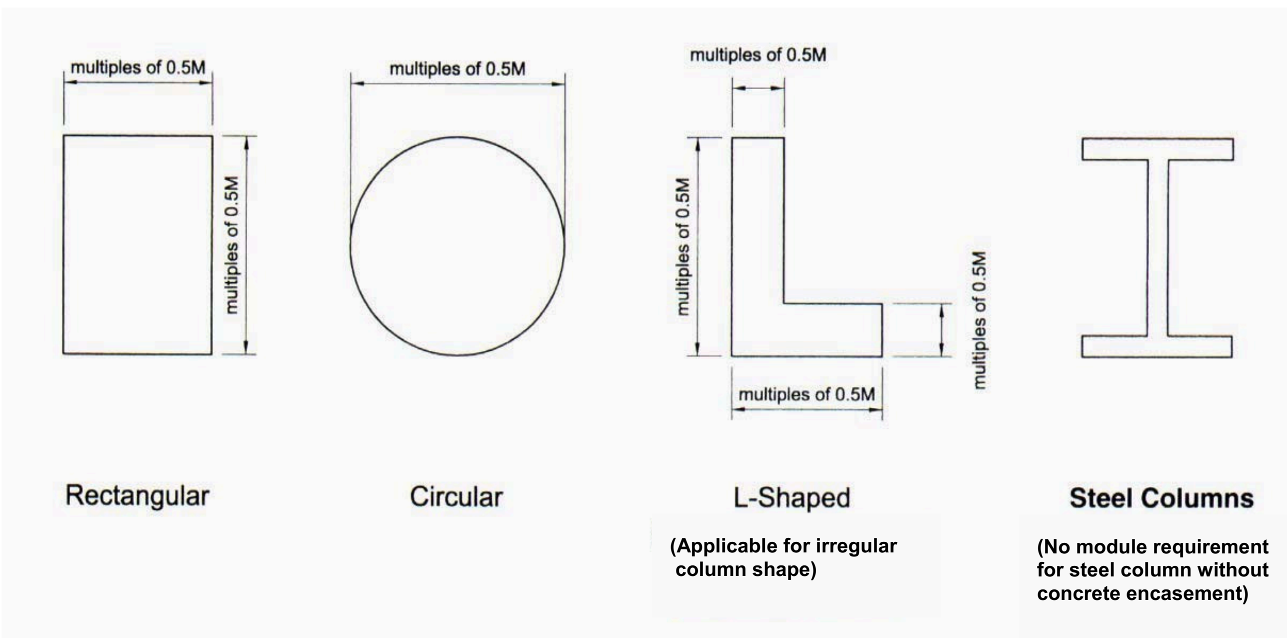
For steel columns encased in concrete, the dimension including the encasement should be used as the size of the column in computation.



Definition of concrete column : $L \leq 4W$

Module

The 3 most common sizes of all column shapes must fit the module requirement of 0.5M, with the exception for steel column (without encasement) as illustrated below:



Module requirement for various column shapes

Coverage

$$\frac{\text{No. of columns (3 most common sizes in 0.5M)}}{\text{Total no. of columns}} \times 100\ \%$$

Measurement – Number of Columns

Description	Method of Measurement
Typical Column	Floor-to-floor height = 1 column
Multi-tier Precast Column	2-tier precast column = 2 columns 3-tier precast column = 3 columns

Grouping Sizes

Column Sizes	Group
400 x 600 and 600 x 400	Considered as same size

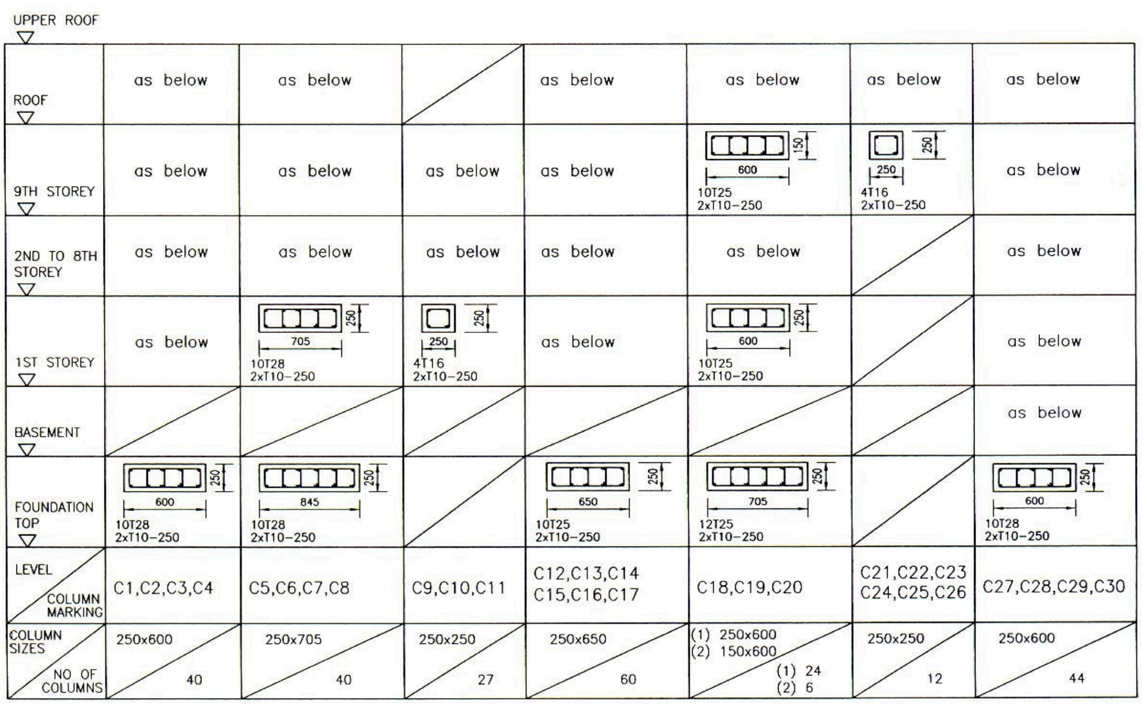
Note : The reinforcement details need not be considered in computation.

Points awarded based on module and percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
0.5M	-	2.00 points

Example BF1 : Computation of Standardisation of Columns

A typical column schedule is shown as follows:



Note:
Assume 1 column marking represents 1 number of column.
C9, C10, C11, C21, C22, C23, C24, C25, C26 are cast in-situ columns.
All other columns are precast columns.

The steps to calculate standardisation of columns are as follows:

Step 1: Group and count columns with same cross-sectional dimension.

Step 2: Identify groups that have the module of 0.5M for cross-sectional dimension.

Step 3: Extract 3 most common sizes with the module of 0.5M.

Step 4: Divide the number of 3 most common sizes by the total number of columns.

Step 5: Points are awarded according to the percentage of coverage.

Step 1: Group and count columns with same cross-sectional dimension

Column Marking	Column Size	Numbers
C1, C2, C3, C4, C18, C19, C20, C27, C28, C29, C30	250 x 600	108
C5, C6, C7, C8	250 x 705	40
C9, C10, C11, C21, C22, C23, C24, C25, C26	250 x 250	39
C12, C13, C14, C15, C16, C17	250 x 650	60
C18, C19, C20	150 x 600	6
	Total	253

Step 2: Identify groups that have the module of 0.5M for cross-sectional dimension

Column Marking	Column Size		Numbers
C1, C2, C3, C4, C18, C19, C20, C27, C28, C29, C30	250 x 600	*0.5M*	108
C5, C6, C7, C8	250 x 705	*Not in module*	40
C9, C10, C11, C21, C22, C23, C24, C25, C26	250 x 250	*0.5M*	39
C12, C13, C14, C15, C16, C17	250 x 650	*0.5M*	60
C18, C19, C20	150 x 600	*0.5M*	6

Step 3: Extract 3 most common sizes with the module of 0.5M

Column Marking	Column Size		Numbers
C1, C2, C3, C4, C18, C19, C20, C27, C28, C29, C30	250 x 600	*0.5M*	108
C5, C6, C7, C8	250 x 705	*Not in module*	40
C9, C10, C11, C21, C22, C23, C24, C25, C26	250 x 250	*0.5M*	39
C12, C13, C14, C15, C16, C17	250 x 650	*0.5M*	60
C18, C19, C20	150 x 600	*0.5M*	6

Step 4: Divide the number of 3 most common sizes by the total number of columns

Number of columns (3 most common sizes) = 108 + 39 + 60

= 207

Total number of columns = 253

Percentage of coverage = 207/253 x 100%

= 82%

Step 5: Points are awarded according to module and percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
0.5M	-	2.00 points

Points awarded = 2.00

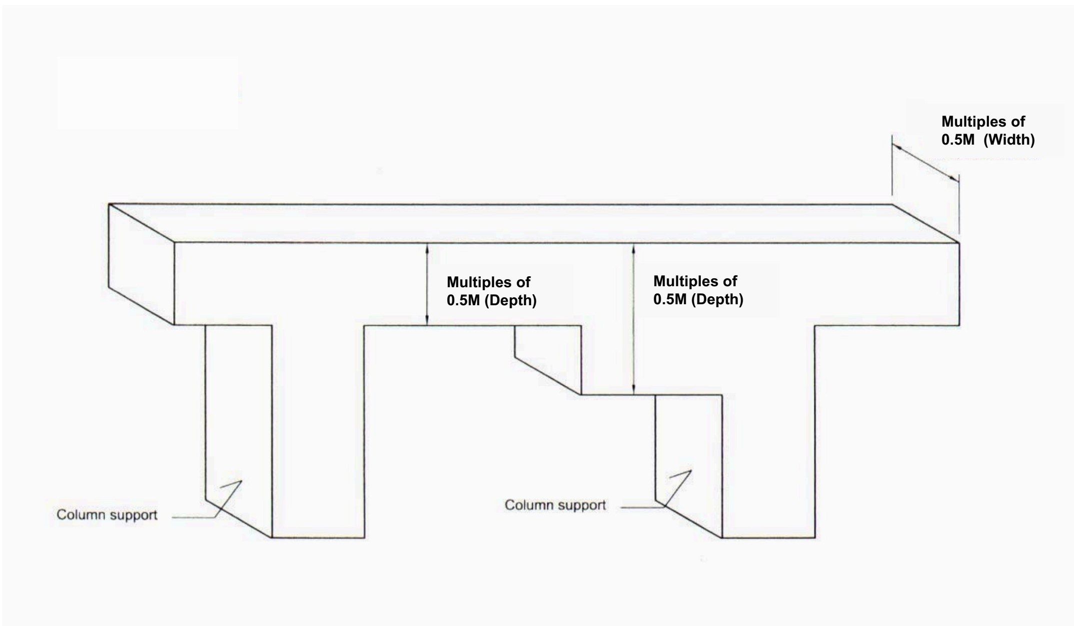
1.2 Beams (3 most common sizes)

All beams should be accounted for. For steel beams encased in concrete, the dimension including the encasement should be used as the size of the beam in computation.

Module

The 3 most common sizes of all beam shapes must fit the module requirement of 0.5M, with the exception for steel beam (without encasement). The module requirement for beams with two or more depths/widths is illustrated as follows:

Illustration 1 - Module requirement for beams with 2 or more depths/widths



Coverage

$$\frac{\text{No. of beams (3 most common sizes in 0.5M)}}{\text{Total no. of beams}} \times 100\ \%$$

Measurement – Number of Beams

Description	Method of Measurement
Typical Beam	Support to Support = 1 beam *see illustration 2
Cantilever Beam	Support to Free end = 1 beam *see illustration 2
Beam with different width/depth	Support to Support = 1 beam *see illustration 3

Illustration 2 - Number of beams to be accounted

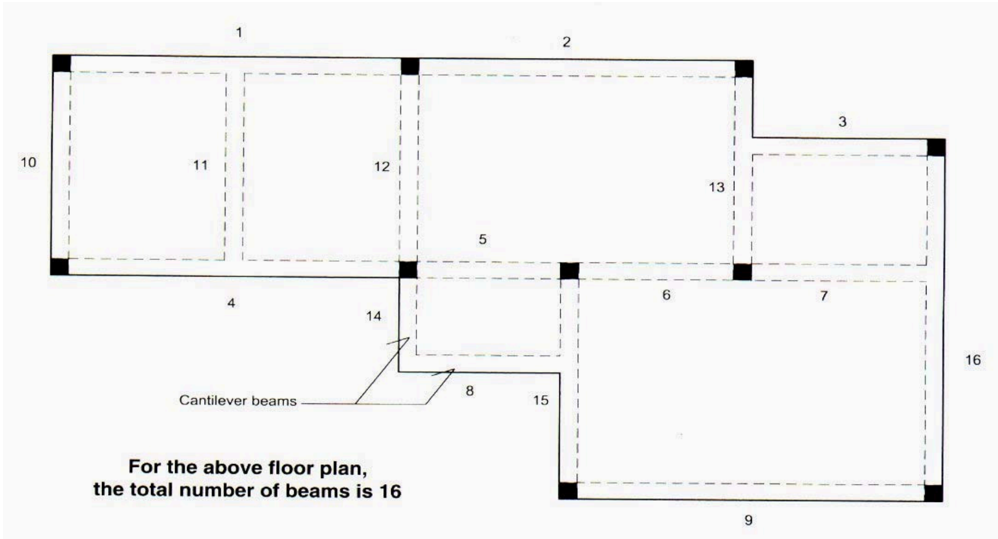
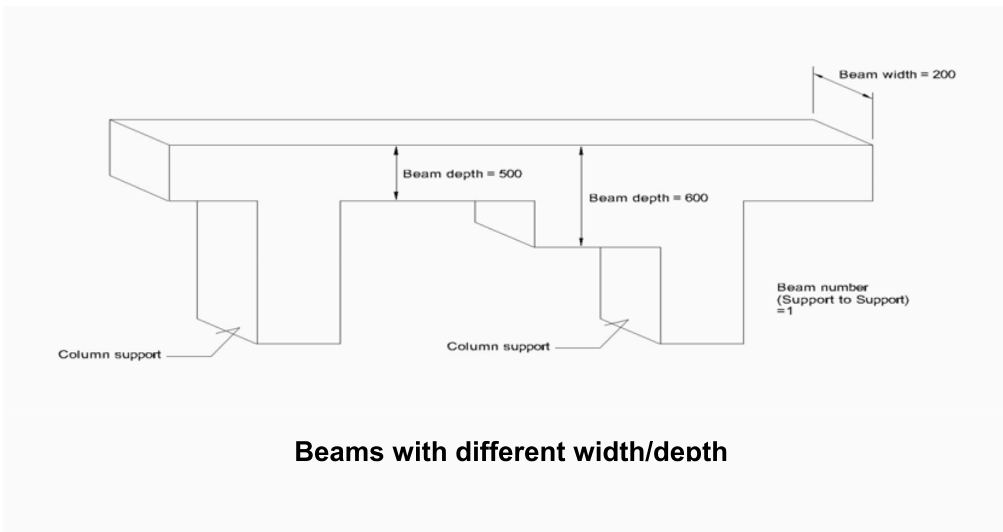


Illustration 3 - Beam with different depth between supports are considered as one beam



Grouping Sizes

Beam Sizes	Group
400 x 600 and 600 x 400	Considered as 2 different sizes

Note : The reinforcement details need not be considered in computation.

Points awarded based on module and percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
0.5M	-	2.00 points

Points awarded = 2.00 points

Example BF2: Computation of Standardisation of Beams

Assume the following information for a 2-storey detached dwelling house:

1st Storey Beams

Beam Marking	Beam Size	Numbers
1B1	300 x 500	15
1B2	300 x 500/800	1
1B3	300 x 600	22
1B4	300 x 600/525	4
1B5	300 x 700	3
1B6	300 x 750	1
1B7	300 x 750/675	1
1B8	300 x 500/700	2
	Total	49

2nd Storey Beams

Beam Marking	Beam Size	Numbers
2B1	300 x 500	14
2B2	300 x 500/800	1
2B3	300 x 600	10
2B4	300 x 700	13
2B5	300 x 800	24
2B6	300 x 500/700	1
	Total	63

Roof Beams

Beam Marking	Beam Size	Numbers
RB1	300 x 500	11
RB2	300 x 600	8
RB3	300 x 700	10
RB4	300 x 800	18
	Total	47

The steps to calculate Standardisation of Beams are as follows:

Step 1: Group and count beams with same cross-sectional dimension.

Step 2: Identify groups that have 0.5M for same cross-sectional dimension.

Step 3: Extract 3 most common sizes with module of 0.5M.

Step 4: Divide the number of 3 most common sizes by the total number of beams.

Step 5: Points are awarded according to the percentage of coverage.

Step 1: Group and count beams with same cross-sectional dimension

Beam Marking	Beam Size	Numbers
1B1	300 x 500	15
2B1	300 x 500	14
RB1	300 x 500	11
1B2	300 x 500/800	1
2B2	300 x 500/800	1
1B8	300 x 500/700	2
2B6	300 x 500/700	1
1B3	300 x 600	22
2B3	300 x 600	10
RB2	300 x 600	8
1B4	300 x 600/525	4
1B5	300 x 700	3
2B4	300 x 700	13
RB3	300 x 700	10
1B6	300 x 750	1
1B7	300 x 750/675	1
2B5	300 x 800	24
RB4	300 x 800	18
	Total	159

Step 2: Identify groups that have 0.5M for same cross-sectional dimension

Beam Marking	Beam Size		Numbers
1B1, 2B1, RB1	300 x 500	*0.5M*	40
1B2, 2B2	300 x 500/800	*0.5M*	2
1B8, 2B6	300 x 500/700	*0.5M*	3
1B3, 2B3, RB2	300 x 600	*0.5M*	40
1B4	300 x 600/525	*Not in module*	4
1B5, 2B4, RB3	300 x 700	*0.5M*	26
1B6	300 x 750	*0.5M*	1
1B7	300 x 750/675	*Not in module*	1
2B5, RB4	300 x 800	*0.5M*	42

Step 3: Extract 3 most common sizes with the module of 0.5M

Beam Marking	Beam Size		Numbers
1B1, 2B1, RB1	300 x 500	*0.5M*	40
1B2, 2B2	300 x 500/800	*0.5M*	2
1B8, 2B6	300 x 500/700	*0.5M*	3
1B3, 2B3, RB2	300 x 600	*0.5M*	40
1B4	300 x 600/525	*Not in module*	4
1B5, 2B4, RB3	300 x 700	*0.5M*	26
1B6	300 x 750	*0.5M*	1
1B7	300 x 750/675	*Not in module*	1
2B5, RB4	300 x 800	*0.5M*	42

Step 4: Divide the number of 3 most common sizes by the total number of beams

Number of beams (3 most common sizes)	= 40 + 40 + 42
	= 122
Total number of beams	= 159
Percentage of coverage	= 122/159 x 100%
	= 77%

Step 5: Points are awarded according to module and percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
0.5M	-	2.00 points

Points awarded = 0.00 points

1.3 Door Leaf Openings (width) (3 most common sizes)

All door leaf opening for doors (see definition below) should be accounted for, with consideration of the following:

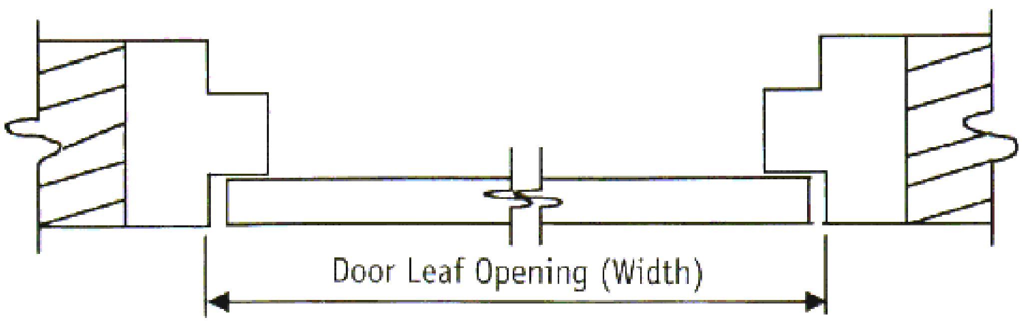
Include

- Roller shutters
- Sliding doors
- Glass doors
- Service doors for substation, switchroom & AHU

Exclude

- Doors for services (M&E risers, TAS risers, fire service risers)
- Doors for civil defence shelters

Note : The type of door material does not affect this computation



Definition of Door Leaf Opening (3 most common sizes)

Coverage

$$\frac{\text{No. of door leaf openings (width) (3 most common sizes)}}{\text{Total no. of door leaf openings}} \times 100\ \%$$

Points awarded based on module and percentage of coverage

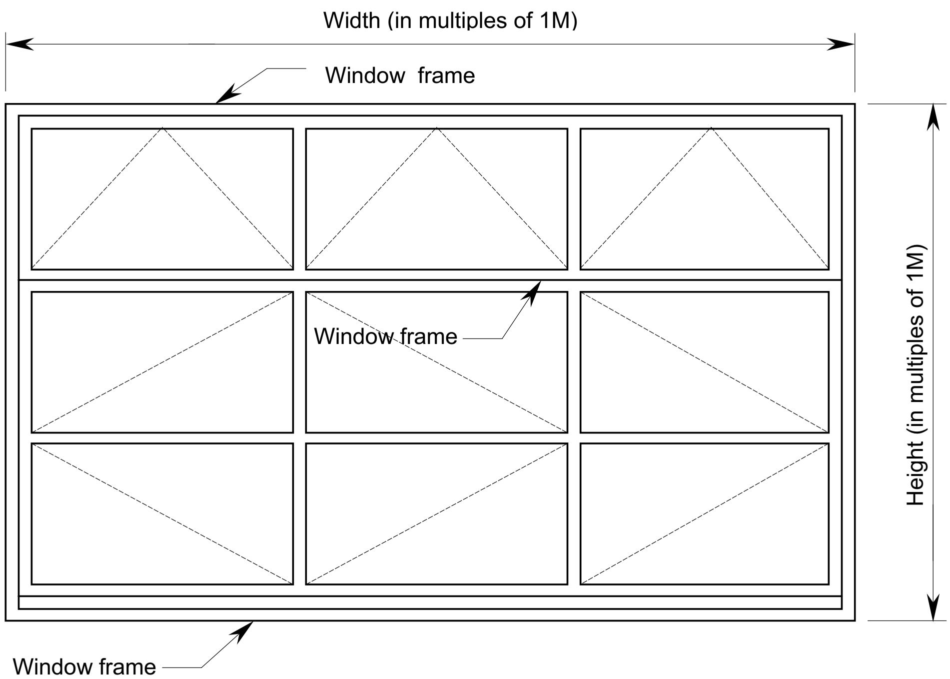
Module	≥ 65% to < 80%	≥ 80%
0.5M (width)	-	1.00 points

1.4 Windows (3 most common sizes)

All windows should be accounted for, including louvres. Non-operable glass within curtain wall system is not to be included in computation.

Module

The 3 most common sizes of windows must fit the module requirement of 1M width and 1M height as illustrated below:



Module Requirement for Window (3 most common sizes)

Note :
(1) The type of window material does not affect this computation.
(2) Window size includes window frame.

Coverage

$$\frac{\text{No. of windows (3 most common sizes in 1M/1M)}}{\text{Total no. of windows}} \times 100\ \%$$

Points awarded based on module and percentage of coverage

Module (Width & Height)	**≥ 65% to < 80%**	**≥ 80%**
1M /1M	-	1.00 points

2 Grids

2.1 Repetition of Floor-to-Floor Height

2.1a Repetition of Floor-to-Floor Height (For block more than 6 storeys)

2.1b Repetition of Floor-to-Floor Height (For block up to 6 storeys)

The floor-to-floor height of all levels inclusive of mezzanine floor level should be accounted for, with the following exceptions:

Exclude

- Top floor and above
- Bottom floor

Criteria

Applicable if there are at least 2 floors after the floor omissions.

Module

The most common floor height must fit the module requirement of 0.5M.

Coverage

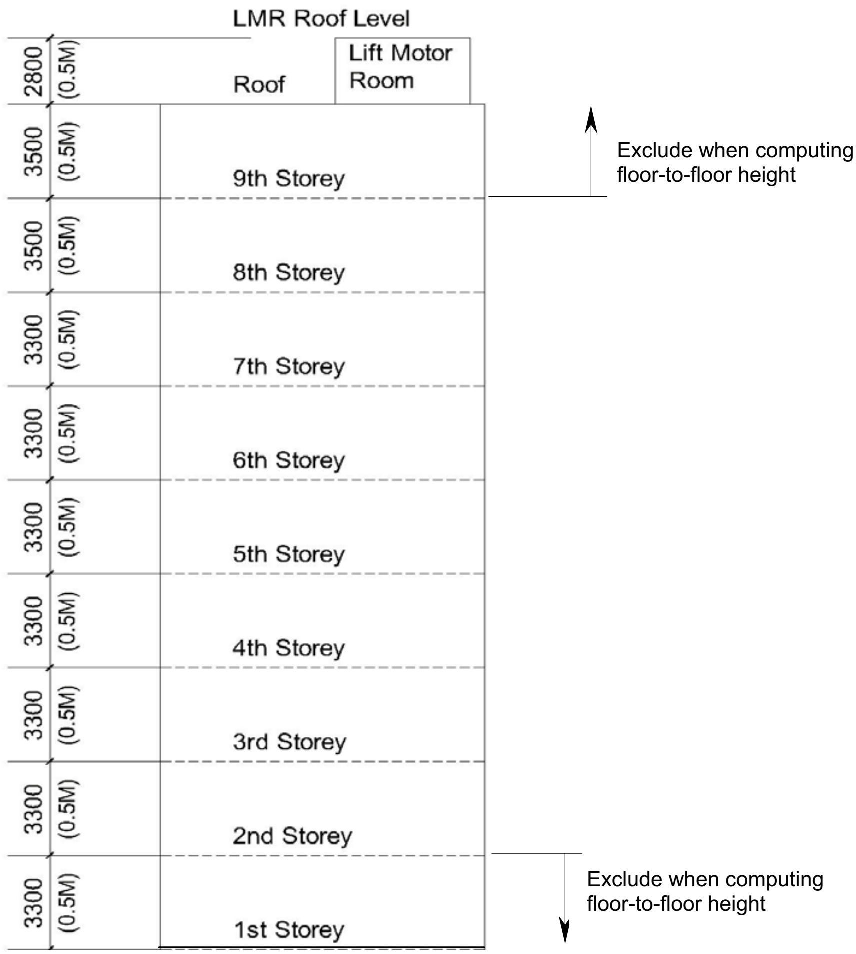
$$\frac{\text{No. of most commonly repeated floor heights with 0.5M}}{\text{Total no. of floor heights}} \times 100\%$$

Points awarded based on module and percentage of coverage

Item	Module	≥ 65% to < 80%	≥ 80%
2.1a	0.5M	1.50 points	2.00 points
2.1b	0.5M	0.75 points	1.00 points

Example BF5 : Computation of Repetition of Floor-to-Floor Height (For block more than 6 storeys)

A typical elevation is shown as follows:



The steps to calculate the repetition of floor-to-floor height are as follows:

Step 1: Group and count number of floor heights.

Step 2: Identify floor heights that have the module of 0.5M.

Step 3: Extract the most common floor heights with the module of 0.5M.

Step 4: Divide the number of the most common floor heights by the total number of floor heights.

Step 5: Points are awarded according to the percentage of coverage.

Step 1: Group and count number of floor heights

Dimensions	Numbers
3500	1
3300	6
Total	7

Note : Top floor & above and bottom floor are excluded

Step 2: Identify floor heights which have the module of 0.5M

Dimensions		Numbers
3500	*0.5M*	1
3300	*0.5M*	6

Step 3: Extract the most common floor heights with the module of 0.5M

Dimensions		Numbers
3500	*0.5M*	1
3300	*0.5M*	6

Step 4: Divide the number of the most common floor heights by the total number of floor heights

Number of the most common floor heights = 6

Total number of floor heights = 7

Percentage of Coverage = 6/7 x 100%

= 85.71%

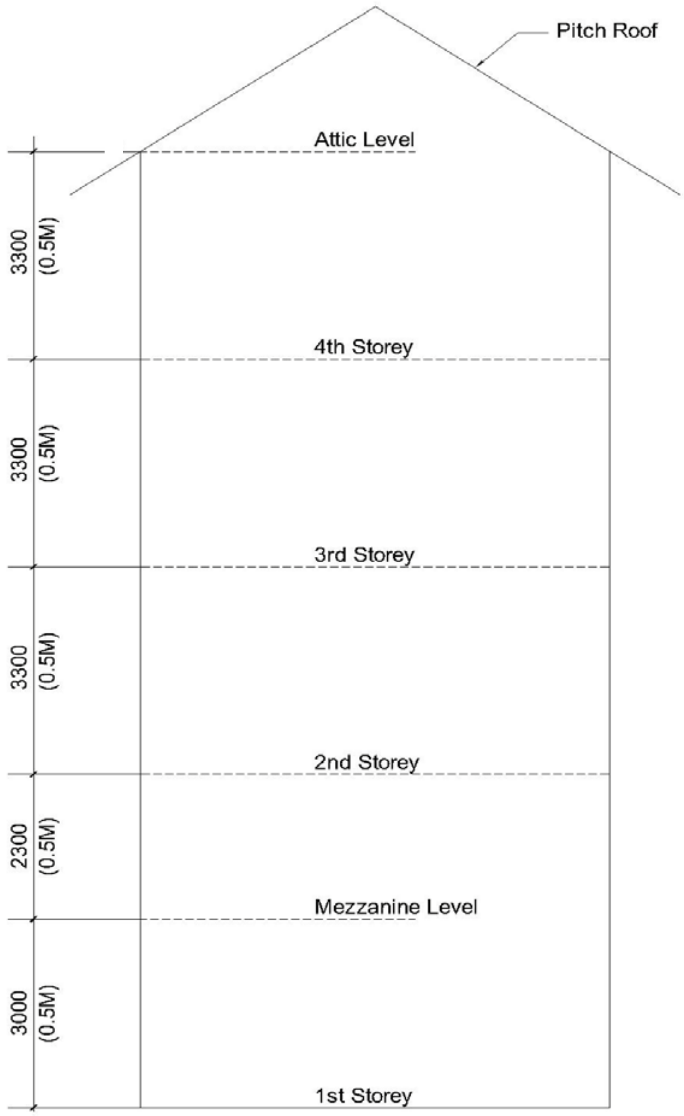
Step 5: Points are awarded according to module and percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
0.5M	1.50 points	2.00 points

Points awarded = 2.00 points

Example BF6: Computation on Repetition of Floor-to-Floor Height (For block up to 6 storeys)

A typical elevation is shown as follows:



The steps to calculate the repetition of floor-to-floor height are as follows:

Step 1: Group and count number of floor heights.

Step 2: Identify floor heights that have the module of 0.5M.

Step 3: Extract the most common floor heights with the module of 0.5M.

Step 4: Divide the number of the most common floor heights by the total number of floor heights.

Step 5: Points are awarded according to the percentage of coverage.

Step 1: Group and count number of floor heights

Dimensions	Numbers
3300	2
2300	1
Total	3

Note : Top floor & above and bottom floor are excluded

Step 2: Identify floor height which have the module of 0.5M

Dimensions		Numbers
3300	*0.5M*	2
2300	*0.5M*	1

Step 3: Extract the most common floor heights with the module of 0.5M

Dimensions		Numbers
3300	*0.5M*	2
2300	*0.5M*	1

Step 4: Divide the number of the most common floor heights by the total number of floor heights

Number of most common floor heights = 3

Total number of floor heights = 2

Percentage of Coverage = 2/3 x 100%

= 67%

Step 5: Points are awarded according to module and percentage of coverage

Item	Module	≥ 65% to < 80%	≥ 80%
2.1b	0.5M	0.75 points	1.00 points

Points awarded = 0.75 points

2.2 Vertical Repetition of Structural Floor Layout

2.2a Vertical Repetition of Structural Floor Layout (For block more than 6 storeys)

2.2b Vertical Repetition of Structural Floor Layout (For block up to 6 storeys)

All floors should be accounted for, with consideration of the following:

Exclude

- Top floor & above
- Bottom floor

Criteria

Applicable if there are at least 2 floors after the floor omissions.

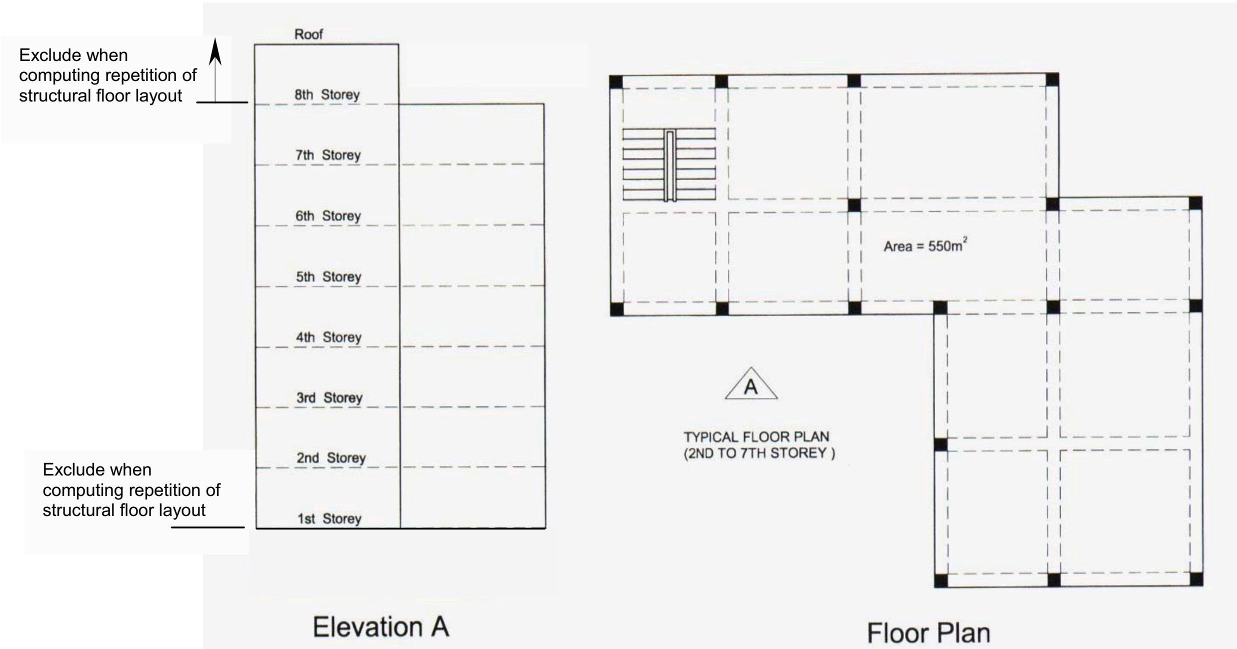
Coverage

$$\frac{\text{Area of floors with most repeated structural floor layout}}{\text{Total floor area}} \times 100\ \%$$

Points awarded based on percentage of coverage

Item	Module	≥ 65% to < 80%	≥ 80%
2.2a	-	1.50 points	2.00 points
2.2b	-	0.75 points	1.00 points

Example BF7: Computation on Vertical Repetition of Structural Floor Layout (For block more than 6 storeys)



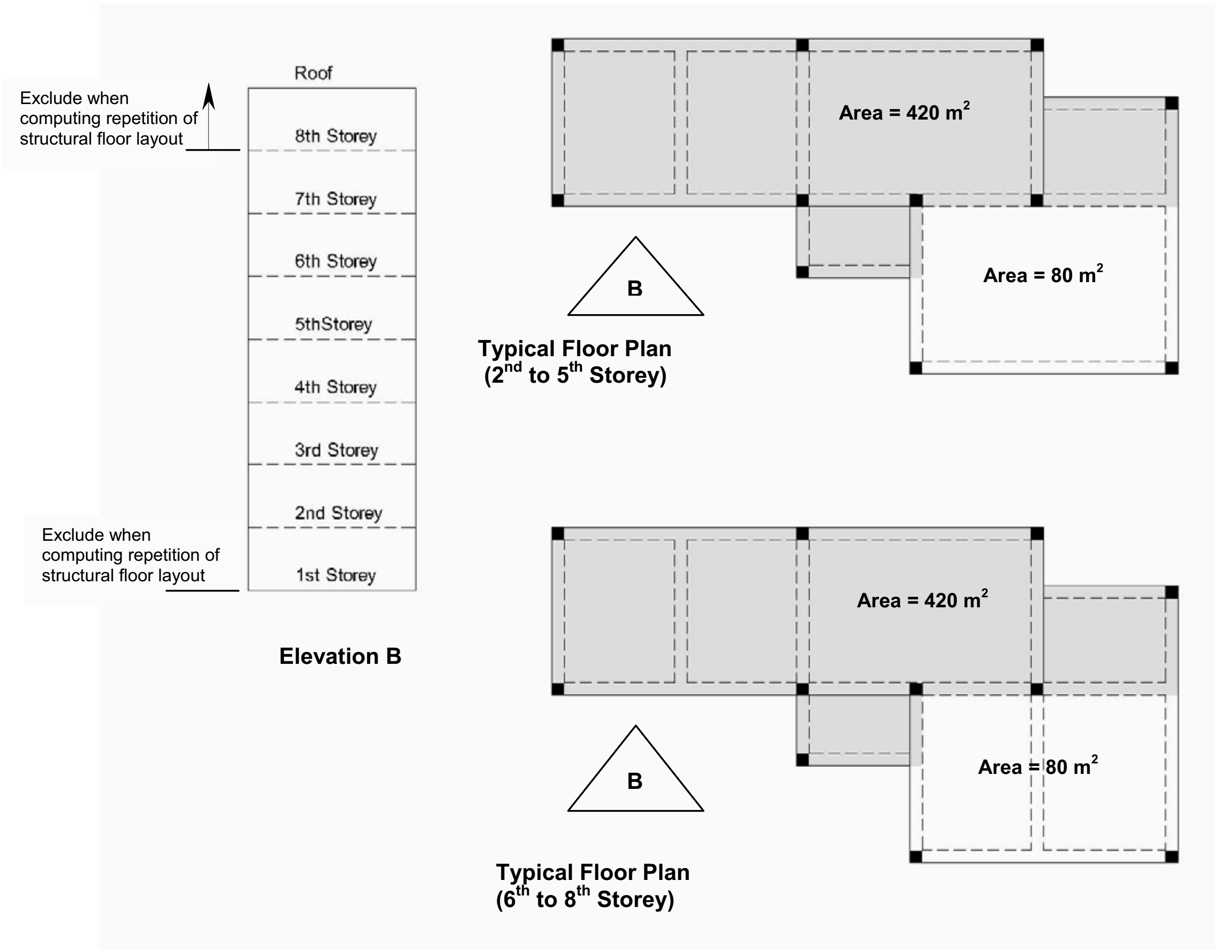
Total area per floor	= 550m^2
Total floor area	= 3300m^2
Area of floors with the most repeated structural floor layout	= 550 x 6
	= 3300m^2
Percentage of Coverage	= 3300/3300 x 100%
	= 100%

Points awarded based on percentage of coverage

Item	Module	≥ 65% to < 80%	≥ 80%
2.2a	-	1.50 points	2.00 points

Points awarded = 2.00 points

Example BF8: Computation on Vertical Repetition of Structural Floor Layout (For block more than 6 storeys)



Total area per floor = $500m^2$

Total floor area = $500m^2$ x 6

= $3000m^2$

Area of floors with the most repeated

Structural floor layout (shaded portion) = $420m^2$ x 6

= $2520m^2$

Percentage of Coverage = 2520/3000 x 100%

= 84%

Points awarded based on percentage of coverage

Item	Module	≥ 65% to < 80%	≥ 80%
2.2b	-	0.75 points	1.00 points

Points awarded = 1.00 points

3 Others

3.1 Multi-tier Precast Columns

Criteria

At least 80% of the total number of columns are precast multi-tier concrete columns.

Coverage

$$\frac{\text{No. of precast columns (multi-tier)}}{\text{Total no. of columns}} \times 100\ \%$$

Measurement – Number of Columns

Each tier is considered as one column. For example, a 3-tier precast columns is considered as 3 columns.

Points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	-	2.00 points

Example:

Number of precast multi-tier columns = 85
Total number of columns = 100
Percentage of coverage = 85/100 x 100%
= 85%

Therefore

Points awarded = 2.00 points

3.2 Precast or Pre-assembled/Metal Staircases

Criteria

At least 80% of the total number of staircases are precast or pre-assembled.

Include

- Precast staircases
- Prefabricated permanent steel stairform complete with reinforcement bars (if required)
- Metal staircases

Coverage

$$\frac{\text{No. of precast or pre-assembled/metal staircases}}{\text{Total no. of staircases}} \times 100\%$$

Measurement – Number of Flights

Every flight of staircase is considered as one number of staircase.

Points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	-	2.00 points

Example:

Number of precast staircases = 36

Total number of staircases = 40

Percentage of coverage = 36/40 x 100%

= 90%

Therefore

Points awarded = 2.00 points

3.3 Precast Meter Chambers

Criteria

At least 80% of the total number of meter chambers are precast.

Coverage

$$\frac{\text{No. of precast meter chambers}}{\text{Total no. of meter chambers}} \times 100\ \%$$

Points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	-	1.50 points

3.4 Precast Refuse Chutes

Criteria

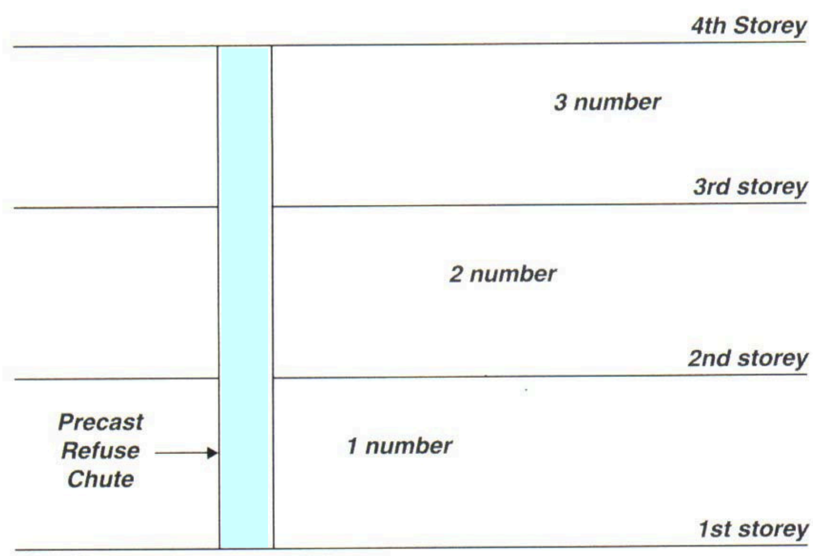
At least 80% of the total number of refuse chutes are precast.

Coverage

$$\frac{\text{No. of precast refuse chutes}}{\text{Total no. of refuse chutes}} \times 100\ \%$$

Measurement – Number of Refuse Chutes

A refuse chute within one floor is considered as one number of shaft. For example if a shaft is extended from the first floor to the fourth floor, it is considered as 3 numbers. (See figure below)



Consideration of Numbers of Shafts

Points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	-	1.50 points

Example:

Number of precast refuse chutes = 90
Total number of refuse chutes = 100
Percentage of coverage = 90/100 x 100%
= 90%

Therefore

Points awarded = 1.50 points

3.5 Precast Service Risers

Criteria

At least 80% of the total number of service risers are precast.

Coverage

$$\frac{\text{No. of precast service risers}}{\text{Total no. of service risers}} \times 100\ \%$$

Points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	-	1.00 points

3.6 Non-screed Floor

Criteria

At least 80% of the total floor area with no screed (i.e. trowel smooth without adding a layer of screeding).

Coverage

$$\frac{\text{Area of non-screed floor}}{\text{Total area of concrete floor}} \times 100\ \%$$

Points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	-	1.00 points

Example:

Area of non-screed floor = 4500m^2

Total floor area = 5000m^2

Percentage of coverage = 4500/5000 x 100%

= 90%

Therefore

Points awarded = 1.00 points

3.7 Columns Sit Directly on Top of Piles

Criteria

At least 80% of the total number of columns (at foundation level) sitting directly on top of piles (i.e. no pilecap).

Coverage

$$\frac{\text{No. of columns sit directly on top of piles}}{\text{Total no. of columns (at foundation level)}} \times 100\%$$

Measurement – Number of Columns (at foundation level)

Every column that sits directly on top of piles is considered as one column.

Points awarded based on percentage of coverage

Module	**≥ 65% to < 80%**	**≥ 80%**
-	-	1.00 points

Example:

Number of columns that sit directly on top of piles = 200

Total number of columns (at foundation level) = 250

Percentage of coverage = 200/250 x 100%

= 80%

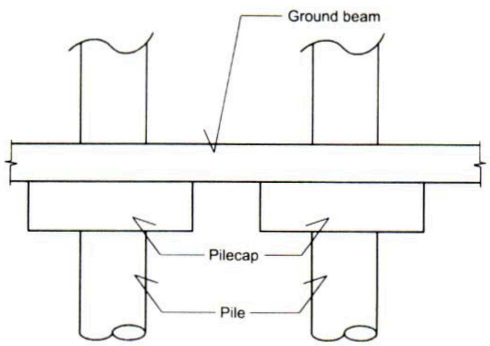
Therefore

Points awarded = 1.00 points

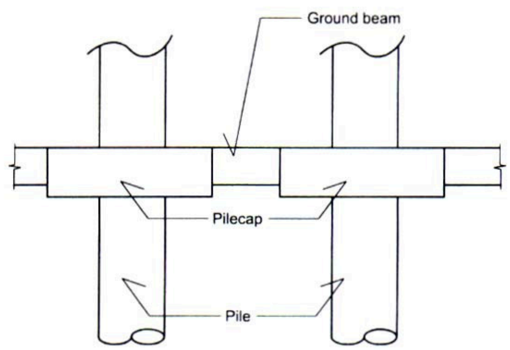
3.8 Ground Beams on Top of Pilecaps and/or Integrated into Pilecaps

Criteria

At least 80% of the total number of ground beams are on top of pilecaps and/or integrated into pilecaps (i.e. no column stump).



Ground beams on top of pilecaps



Ground beams integrated into pilecaps

Coverage

$$\frac{\text{No. of ground beams on top of pilecaps and/or integrated with pilecaps}}{\text{Total no. of ground beams}} \times 100\%$$

Measurement – Number of Ground Beams

Every ground beam from support to support (i.e. pilecaps) is considered as one beam.

Points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	-	1.00 points

Example:

Number of ground beams on top of pilecaps = 220

Total number of ground beams = 250

Percentage of coverage = 220/250 x 100%

= 88%

Therefore

Points awarded = 1.00 points

A Single Integrated Components (Bonus Points)
A.1 Prefabricated Bathroom/Toilet Units Complete with Piping/Wiring

Criteria
At least 65% of the total number of bathroom/toilet units are prefabricated.

Coverage
$$\frac{\text{No. of prefabricated bathroom/toilet units}}{\text{No. of bathroom/toilet units}} \times 100\%$$

Measurement – Number of Bathroom/Toilet Units
Every bathroom/toilet unit is considered as one number.

Bonus points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	2.00 points	3.00 points

Example:
Number of prefabricated bathroom/toilet units = 50

Total number of bathroom/toilet units = 60

Percentage of Coverage = 50/60 x 100%

= 83%

Therefore

Points awarded = 3.00 points

A.2 Precast Household Shelters

Criteria

At least 65% of the total number of household shelters are precast.

Household shelter is considered as precast if the total length of the in-situ joints is not more than 20% of its wall perimeter on plan.

Coverage

$$\frac{\text{No. of precast household shelters}}{\text{Total no. of household shelters}} \times 100\%$$

Measurement – Number of Precast Household Shelters

Every individual precast household shelter unit is considered as one number.

Bonus points awarded based on percentage of coverage

Module	≥ 65% to < 80%	≥ 80%
-	2.00 points	3.00 points

Example:

If cast in-situ joints are used, first check on the percentage of cast in-situ joint length over its wall perimeter on plan.

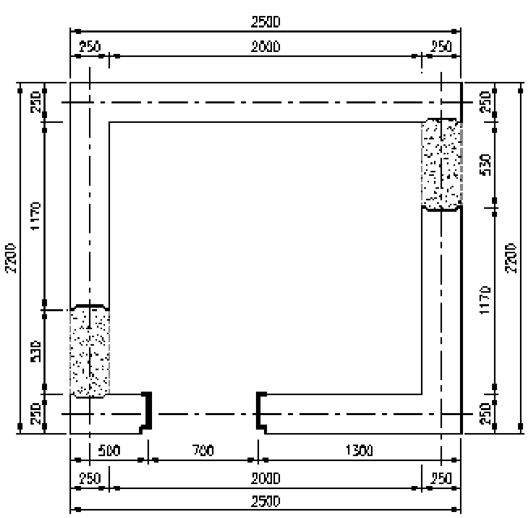
Criteria Check

Total length of cast in-situ joint = 530 x 2 = 1060 mm

Total wall perimeter = (2500-125-125) + (2200-125-125) x 2 + (2500-700-125-125)

(measured along centerline) = 7700 mm

% Cast in-situ joint length over its wall perimeter = 1060/7700 x 100% = 13.77% < 20%



Typical Precast Household Shelter
SECTIONAL PLAN

Therefore, the household shelter shown on the plan can be considered as precast.

Number of precast household shelters = 75

Total number of household shelters = 100

Percentage of coverage = 75/100 x 100% = 75%

Therefore

Points awarded = 2.00 points

B Demerit Points

B.1 Non-functional Void on Slab

Criteria

A void on a slab enclosed by full walls / columns that do not serve any functional requirement such as a void that results solely from a design to suit GFA computation. On the other hand, a void such as a duct for services is considered a functional void.

Coverage

As long as there is a non-functional void within a block.

Demerit Points given

Module	Point deduction
-	-1.00 point

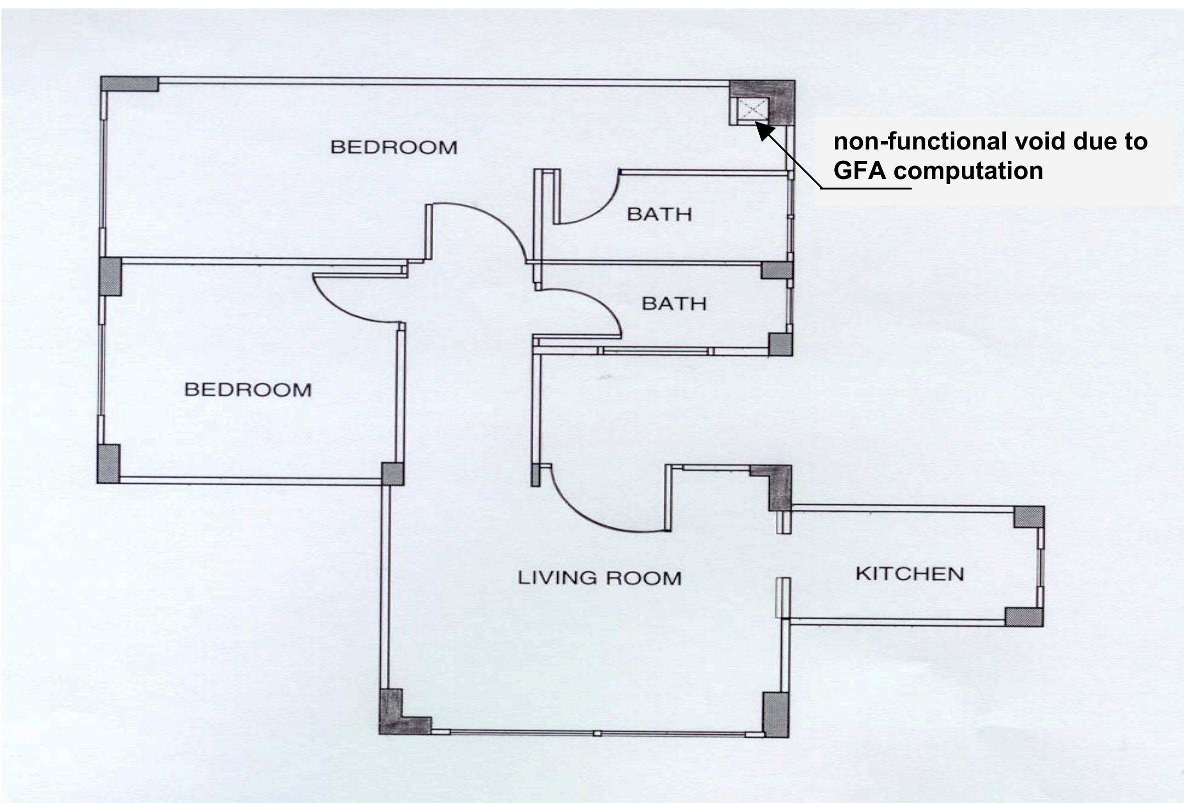


Illustration of a non-functional void within a dwelling unit