EXAM MASTERY

Past Paper Suggested Solutions & Winning Strategies for HKIE / IStructE Exam

VOLUME 1

By Structural Fireman

DESCRIPTION

每年都有工程師因為準備不足而失手。不是他們不夠努力，而是方向錯了。
IStructE Exam Mastery 由一群通過考試的註冊工程師編寫，我們深明考生的困難：
- 資料太多，不知重點
- 時間有限，無從入手
- Past Paper 無從參考

我們將多年經驗濃縮成這本攻略：
✅ 歷屆 Past Paper 參考答案
✅ 清晰知識框架及記憶法

📚 涵蓋內容
本攻略為此系列的 Volume 1，將會詳細拆解 4 份 IStructE Building Past Paper 題目如下：

#	Exam Date	Question
1	January 2019	Q2. Mixed Use Building
2	September 2021	Q1. Residential Building with Basement Car Park
3	July 2023	Q1. Medical Centre Building
4	January 2025	Q2. Government Building

本攻略會提供：
✅ 參考答案及解題思路
✅ 評分要點分析
✅ 常見答題框架
✅ 考官期望重點

每條題目均附：
- 詳細解題步驟
- 關鍵技術、考慮要點
- 完整參考答案

掌握答題模式，了解評分標準，
讓你在考試中有效展示專業知識，
大大提升合格機會。

⚠ 聲明：本書提供參考答案及學習方向，實際考試需根據題目要求作答

CONTENTS

2019 JANUARY Q2: MIXED USE BUILDING

Question 2. Mixed use building

Client's requirements

1. A new six-storey mixed-use building is to be constructed in a city centre on a plot adjacent to an existing main road. See Figure Q2.
2. The finished floor-to-floor heights for the shopping and office floors are 5.0m and 4.0m respectively. Minimum clear floor-to-ceiling heights of 3.65m and 2.80m are required in shopping and office floors respectively, with a minimum 400mm ceiling void for services. The clear floor-to-ceiling height in the concourse area must be at least 6.5m with a minimum 500mm ceiling void for services.
3. The concourse and canteen are in the middle part of the building on Level 1 and Level 5 and have twice the clear floor heights of shop and office floors respectively. The roof above the canteen area must be glazed to allow the entry of natural light.
4. Two lift/staircase cores are to be provided over the full height of the building as shown in Figure Q2.
5. The front elevation of the building will be fully glazed. 65% of the side and rear elevations will be glazed and the remainder will be clad with stone panels. No bracing is allowed in the front elevation.
6. No internal columns are permitted in the concourse zone of the building. Elsewhere, internal and external columns must be placed not less than 7.00m apart.

Imposed loading

7.

Roof	1.5 kN/m²
Office/Canteen	5.0 kN/m²
Shops/Concourse/Entrance	7.5 kN/m²

Site conditions

8. The site is located in the centre of a large city. The basic wind speed is 40m/s based on a 3-second gust; the equivalent mean hourly wind speed is 20m/s.

9. Ground conditions:

Borehole 1:

Existing Ground level – 1.0m	Top soil and fill
1.0m – 6.0m	Dense silty sand Φ = 33 degrees
6.0m – 9.5m	Dense sand N=30
Below 9.5m	Rock, characteristic compressive strength = 4,500kN/m²

Borehole 2:

Existing Ground level – 1.0m	Top soil and fill
1.0m – 4.5m	Sand and gravel N=15
Below 4.5m	Rock, characteristic compressive strength = 4,500kN/m²

Ground water was encountered at 6.3m below ground level in BH1 and at 1.3m below ground level in BH2.

Omit from consideration

10. Detailed design for staircases and lifts within cores; glazed facades.

SECTION 1 **(50 marks)**

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure including the foundations. Indicate clearly the functional framing, load transfer, serviceability, and stability aspects of each scheme. Review and critically appraise the schemes, and identify the solution you recommend, giving reasons for your choice. (40 Marks)

b. After completion of the design and before construction has started, the Client informs you that the area designated for open-air parking at the front of the building will instead be landscaped, and asks you to incorporate a basement under the full plan area of the building, to accommodate parking for 100 cars. Write a letter to the Client explaining the implications on your design. (10 marks)

SECTION 2 **(50 marks)**

For the solution recommended in Section 1(a):

c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)

d. Prepare general arrangement drawings which may include plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details for estimating purposes. (20 marks)

e. Prepare a detailed method statement for the safe construction of the building and an outline construction programme, including consideration of any temporary works that may be required) (10 marks)

CLIENT'S REQUIREMENT & LOGICAL THINKING PATH

#	Client's Requirement	Think about ……
1	Six-storey building + City Centre	Progressive collapse to consider & Piling Wall & ELS works required
2	Floor Height / Finishing Requirement	Structural Depth of Each Floor ➔ If large structural zone: consider transfer
3	Roof above must be glazed to allow natural night	No Structural at the glazed roof zone
4	Two lift / staircase core	RC Core wall / Braced Core can be used as lateral stability system
5	Front Elevation Glazed + No Bracing; 65% of the side and rear elevations will be glazed	To be shown in full version
6	No internal columns are permitted in the concourse; 7m c/c for internal & external column spacing	

COLUMN SPACING PRINCIPLES

Floor plan: X-direction = 60m; with internal concourse = 24m

Scheme 1: Shorter Span with Cantilever (aims to have cantilever for distinct solution)
LEFT / RIGHT: 18m = 3m Cantilever + **7.5m** x 2 > 7m c/c requirement, OK!
MIDDLE: 24m = **8m** x 3 > 7m c/c requirement, OK!

Total: 8 nos. of columns in X-direction with 2 sides cantilever

Scheme 2 Longer Span: 左右剩 18m = 9m + 9m; 中間 24m = 12m + 12m
LEFT / RIGHT: 18m = **9m** x 2 > 7m c/c requirement, OK!
MIDDLE: 24m = **12m** x 2 > 7m c/c requirement, OK!

Total: 8 nos. of columns in Y-direction for Scheme 1

Floor plan: Y-direction = 60m; with internal concourse = 28m

Scheme 1: Shorter Span: 考慮細 spacing
TOP / BOTTOM: 16m = **8m** x 2 > 7m c/c requirement, OK!
MIDDLE: 28m = **9m** x 2 + **10m** x 1 > 7m c/c requirement, OK!

Total: 7 nos. of columns in Y-direction for Scheme 1

Scheme 2 Longer Span: 直接 60 / 12m = 5
TOTAL: 60m = **12m** x 5 > 7m c/c requirement, OK!

Total: 6 nos. of columns in Y-direction for Scheme 2

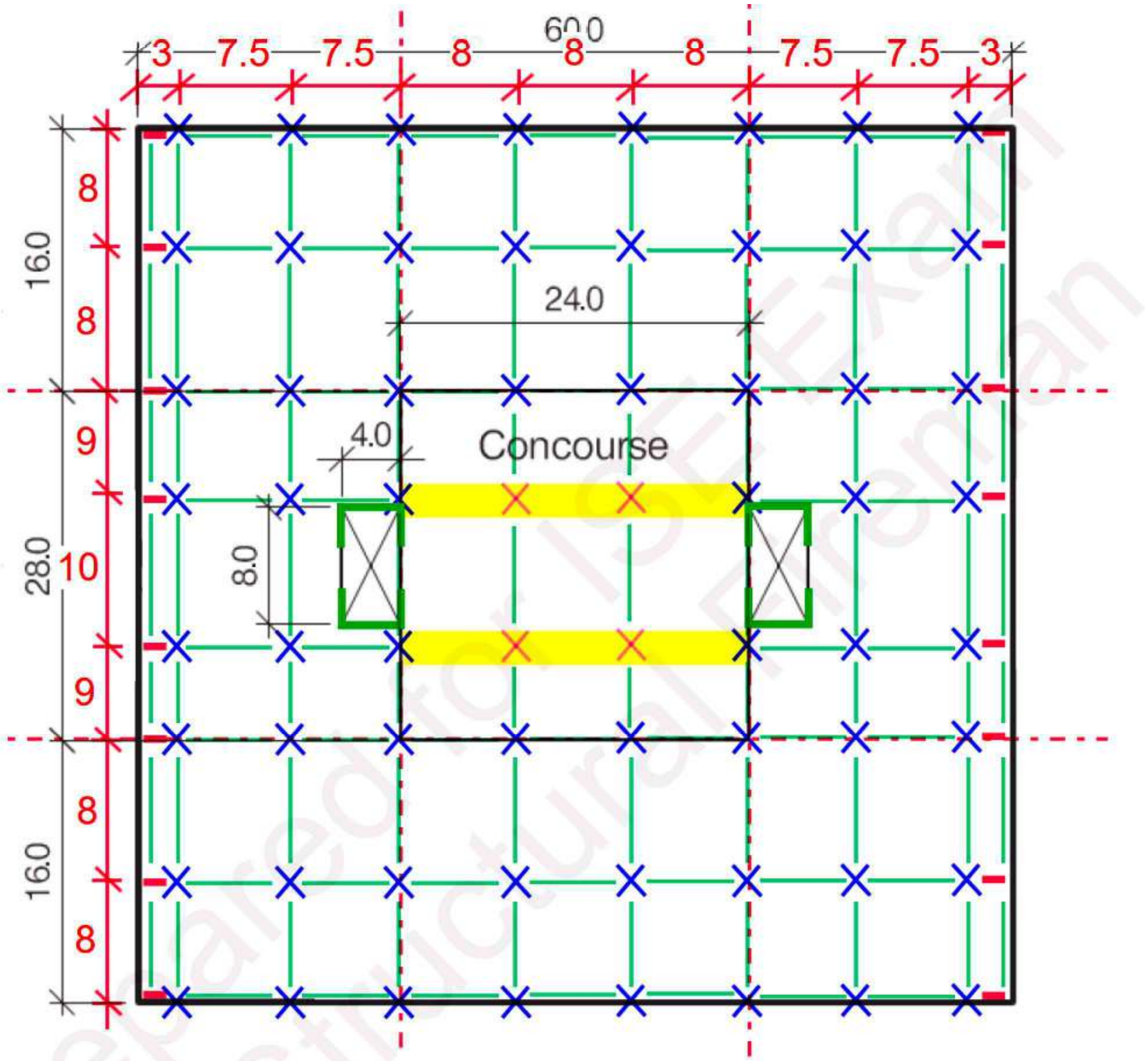
TIPS

1. 不一定要區分不同的 zone 而決定 column spacing，兩個 scheme 只需要不同數目的 column 就可以。
2. 如題目沒有限制 service core 跟 column spacing，則可以不需理會。
3. Scheme 1 主要為 concrete 所以 span 一般比較短；而 Scheme 2 主要為 structural steel，所以 column spacing 一般較長。
4. 題目如要求 7m c/c，盡量留有小量空間，例如 7.5m c/c 留有空間備用。

Column Spacing Summary

Scheme	X-Direction	Y-Direction
1	8 columns + 3m Cant.	8
2	7	6

SCHEME 1 SUMMARY

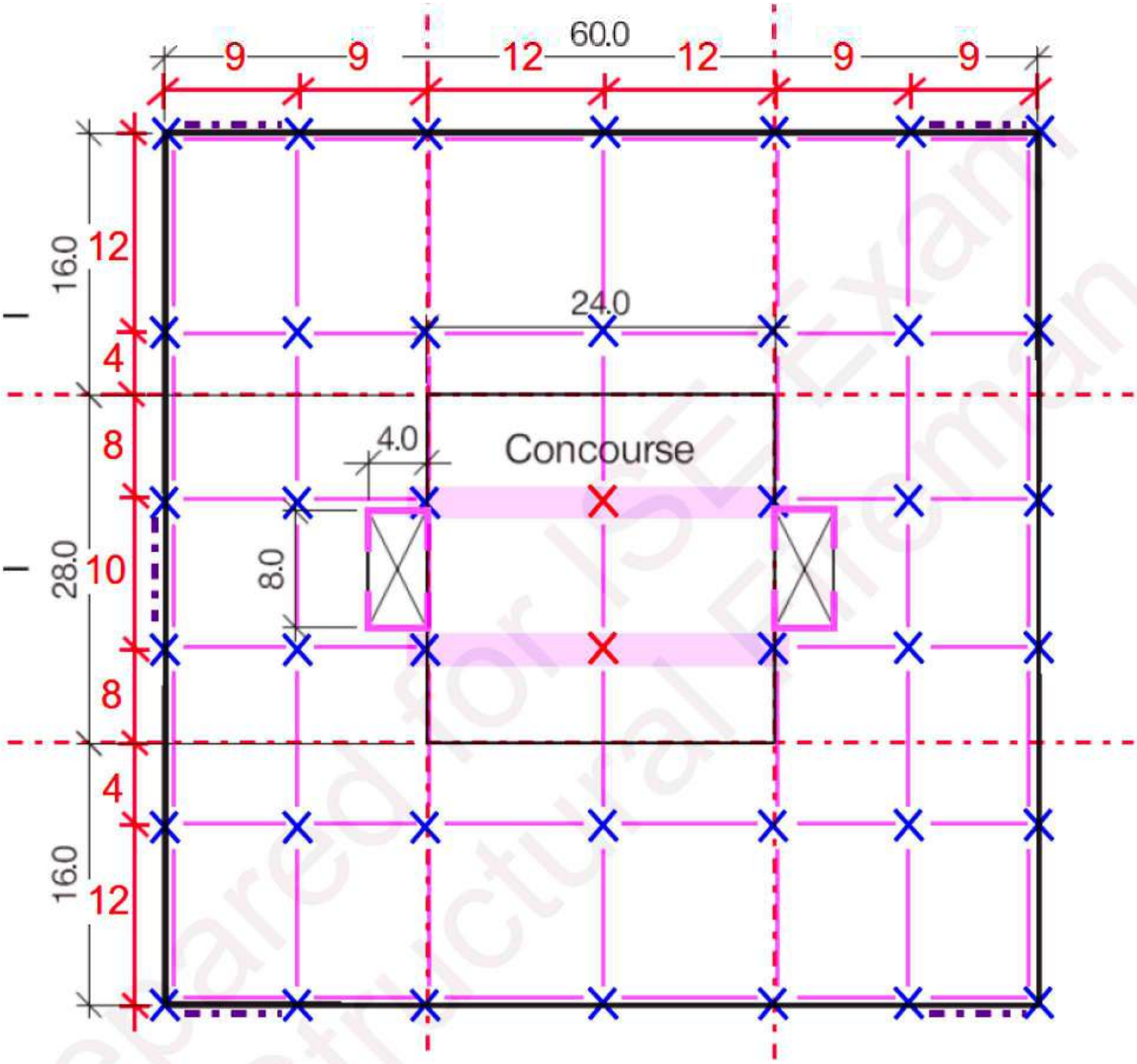


Scheme 1

LEGEND

- COLUMN FROM L1 TO R/F
- COLUMN TO BE TRANFER AT L3
- RC TRANSFER BEAM AT L3
- RC CORE WALL
- RC BEAM B1

SCHEME 2 SUMMARY



Scheme 2

LEGEND
- COLUMN FROM L1 TO R/F
- COLUMN TO BE HANGERED FROM L3 TO R/F
- ROOF TRUSS AT L3
- BRACED CORE
- STEEL BEAM SB1
- STEEL BRACING

SUGGESTED SOLUTIONS

SECTION 1 (A) – DESIGN APPRASIAL

INTRODUCTION

A new 6 storeys building is to be built.
It's located in the Urban area with size in 60m x 60m and height in 28m.

DESIGN APPRAISAL

#	Client's Requirement / Site Conditions	Implications to Design
1	City Centre	Piling wall and ELS works required and sufficient monitoring checkpoints to be placed adjacent to site
2	6 storeys	
3	Headroom (HR) (m)	
4	Gravity Load	To be shown in full version
5	Wind Load	

ASSUMPTION

1. The site locates in Hong Kong.
2. There is sufficient space on site to allow for all construction methods and materials storage.
3. Existing buildings are far enough away for construction not to affect them.
4. Fire resistance period to be 2hrs.

SCHEME OPTION DRAFT

#	Type	Scheme 1	Scheme 2
1	Materials	Reinforced Concrete	Steel Composite
2	Structural Grid	7.5 – 8m x 8 – 10m	9 – 12m x 10 – 12m
3	Vertical Stability System	RC Transfer Beam at 3/F	Steel Truss at Roof
4	Lateral Stability system		
5	Beam-slab Arrangement		
6	Foundation System		
7	Retaining System / ELS Method		

To be shown in full version

SCHEME 1: IN-SITU RC BEAM-SLAB SYSTEM WITH TRANSFER PLATE AT 3/F

1.1 Structural Scheme

Option 1 is a RC beam-slab frame, with columns / core wall generally on a 7.5 - 8m x 8 - 10m grid, the details of structural system is described as follows:

- 175mm
  in max.
- Second
  suppor
- For eas
  floor.
- Transfe
  column

To be shown in full version

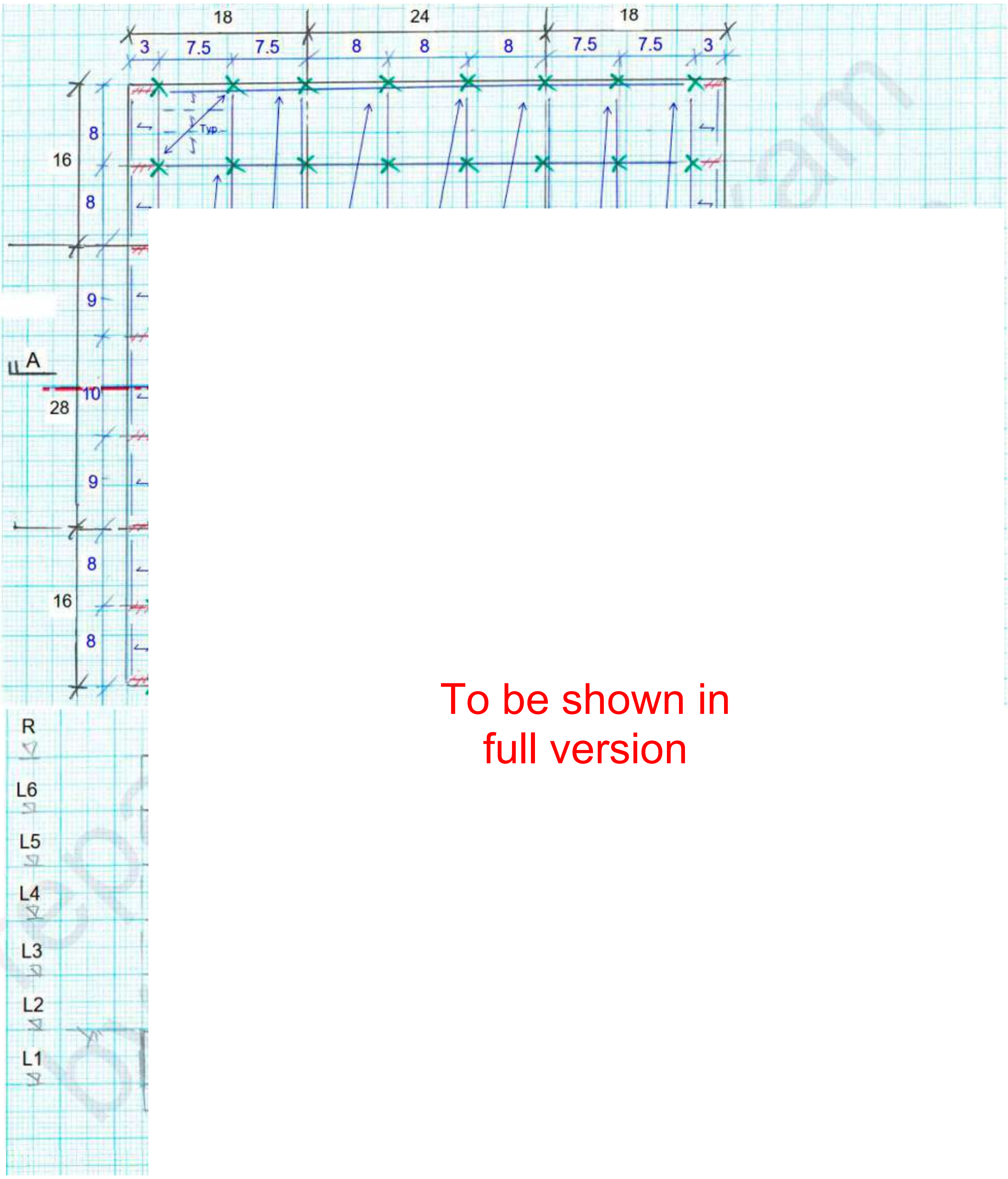
1.2 Sustainability Considerations

- Strategic use of cantilever beams (3-4m spans) eliminates need for additional columns, reducing foundation works
- Hier
  tran
- Reg
  was
- RC
  cons

To be shown in full version

1.3 Functional Framing Plan

(Use graph paper to draw)



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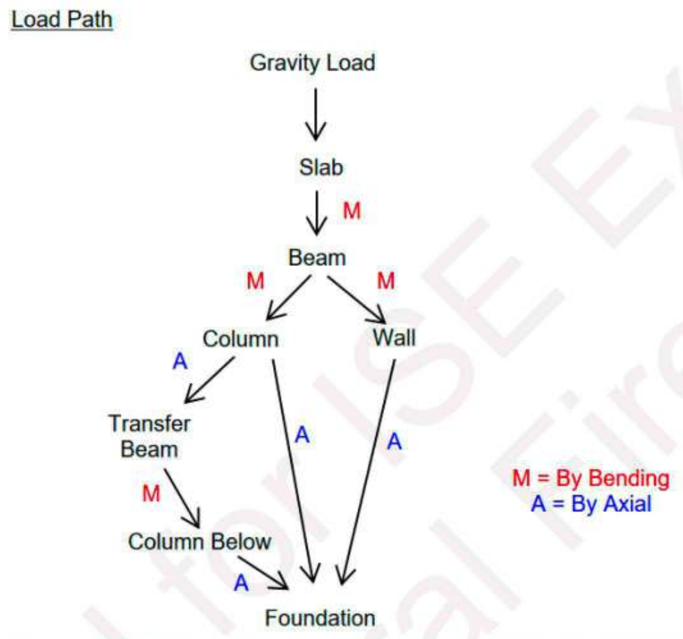
1.4 Load Transfer and Stability

1. Gravity Load

The gravity loads shall be supported by floor slabs, beams, columns and core wall and transfer beams down to the foundations as figures below and load path described below.



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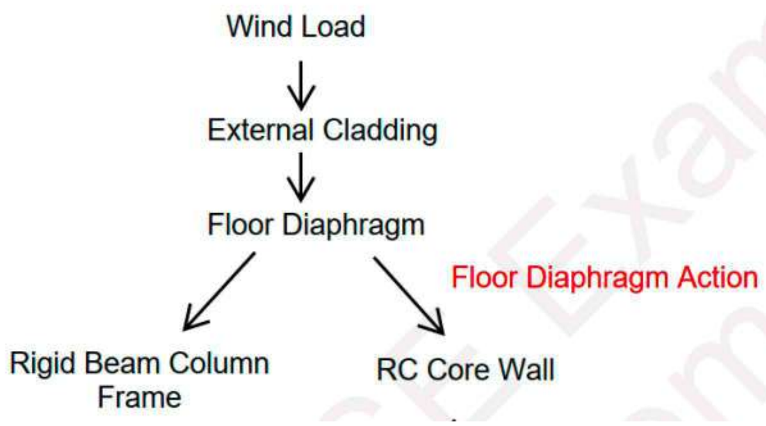
2. Lateral Load

Lateral stability is provided by the rigid beam column framework and core wall, down to the foundation.



To be shown in full version

1.5 Feasibility Sizing and Calculations

1. Slab S1 (175 mm thk.)

Span L = 3.33 m
d = H – 25 – 10 / 2 = 145 mm
L / d = 22.9 < 23, OK!

2. Beam B1 & B2 (800 mm dp.)

Span L = 10 m
d = H – 40 – 10 – 40 / 2 = 730 mm
L / d = 13.7 < 23, OK!

3. Cantilever

4. Column C

Assume

Tributa

Use C45
Axial (

To be shown in full version

5. Transfer Beam TB1 (3000 x 2500dp.)

Assume 10kPa DL and 5kPa LL per floor,

Storey = 5 (L3 – L6 + R/F)

Tributary Area = 8 m x 10m

Load = (10 x 1.4 + 5 x 1.6) x (10 x 8) x 5 storeys

= 8800 kN

Shea

M

To be shown in full version

Modificat

1.6 Progressi

1. Progressi
- Design bu
- Provide su
- Provide al

2. Deflection

Pre-camberin

3. Atrium Gla

Steel beams s
glazing.

1.7 Basement Scheme

1. Construction Method

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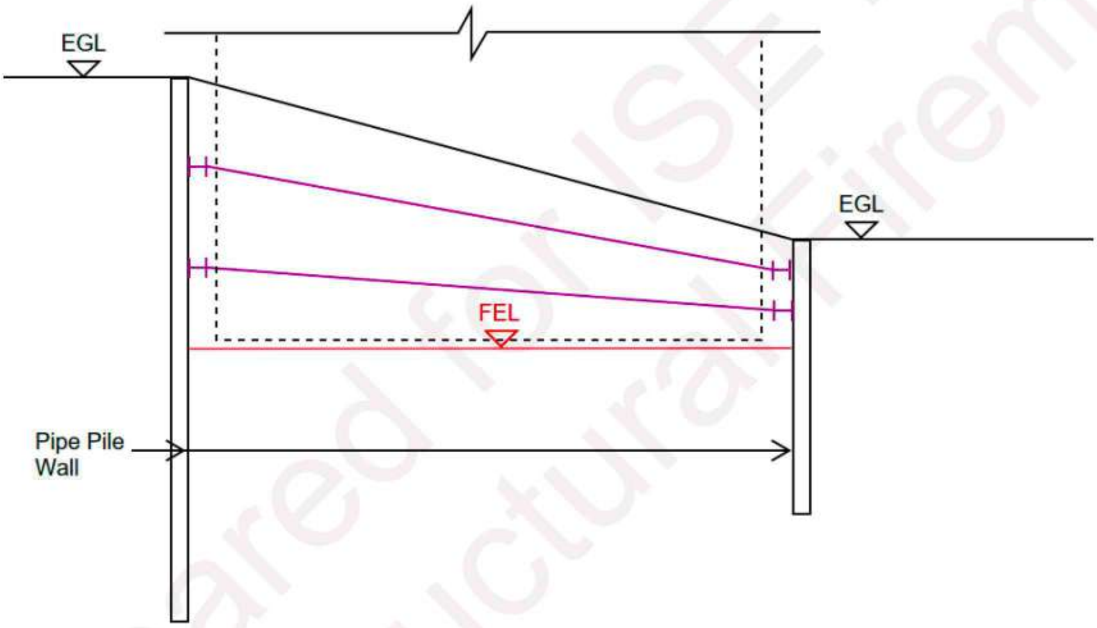
To be shown in
full version

The
insta

The

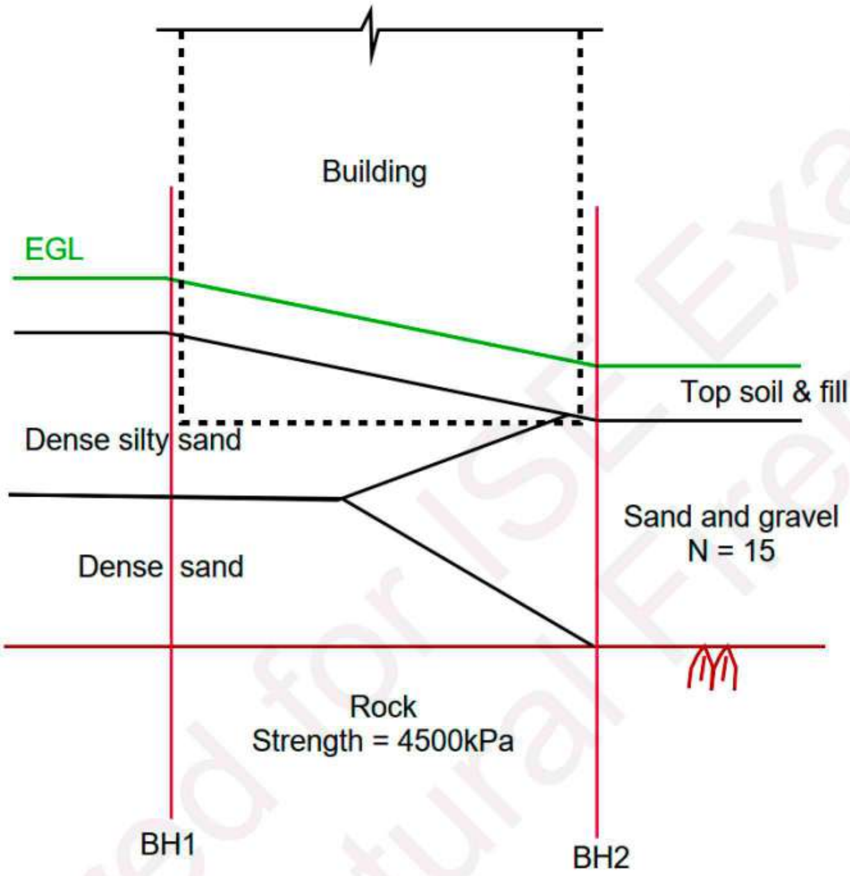


2. Structural System

To be shown in
full version

1.8 Foundation Scheme

<u>Ground Conditions</u>

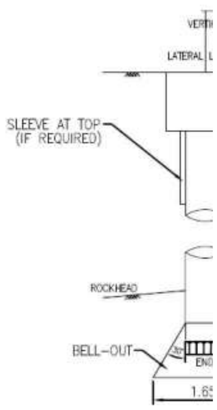


Scheme 1: Large Diameter Bored Piles

Bored piles founded on rock adopted due to:

- Weak shallow soil
- High column loads
- Rock provides adequate bearing & minimal settlement

1. Load Path



To be shown in full version

2. Feasibility

Pile

Pile Ca

Allowable Col

Compressiv

Provide

Capacity =	1	x $\pi(1.65(D-0.15))^2/4$ x 4500	
=	17536	kN	
>	11340	kN	∴OK!

Uplift, Shear capacity and deflection of pile to be checked in detailed design stage.

SCHEME 2: STEEL COMPOSITE BEAM-SLAB SYSTEM WITH STEEL TRUSS AT ROOF

2.1 Structural Scheme

Option 2 is a Steel Composite beam-slab frame, with columns generally on a 9-12m x 10-12m grid, the det

- One-way slab 10m.
- Secondary bea supported by s
- No cantilever b
- Roof Truss in s below and pro

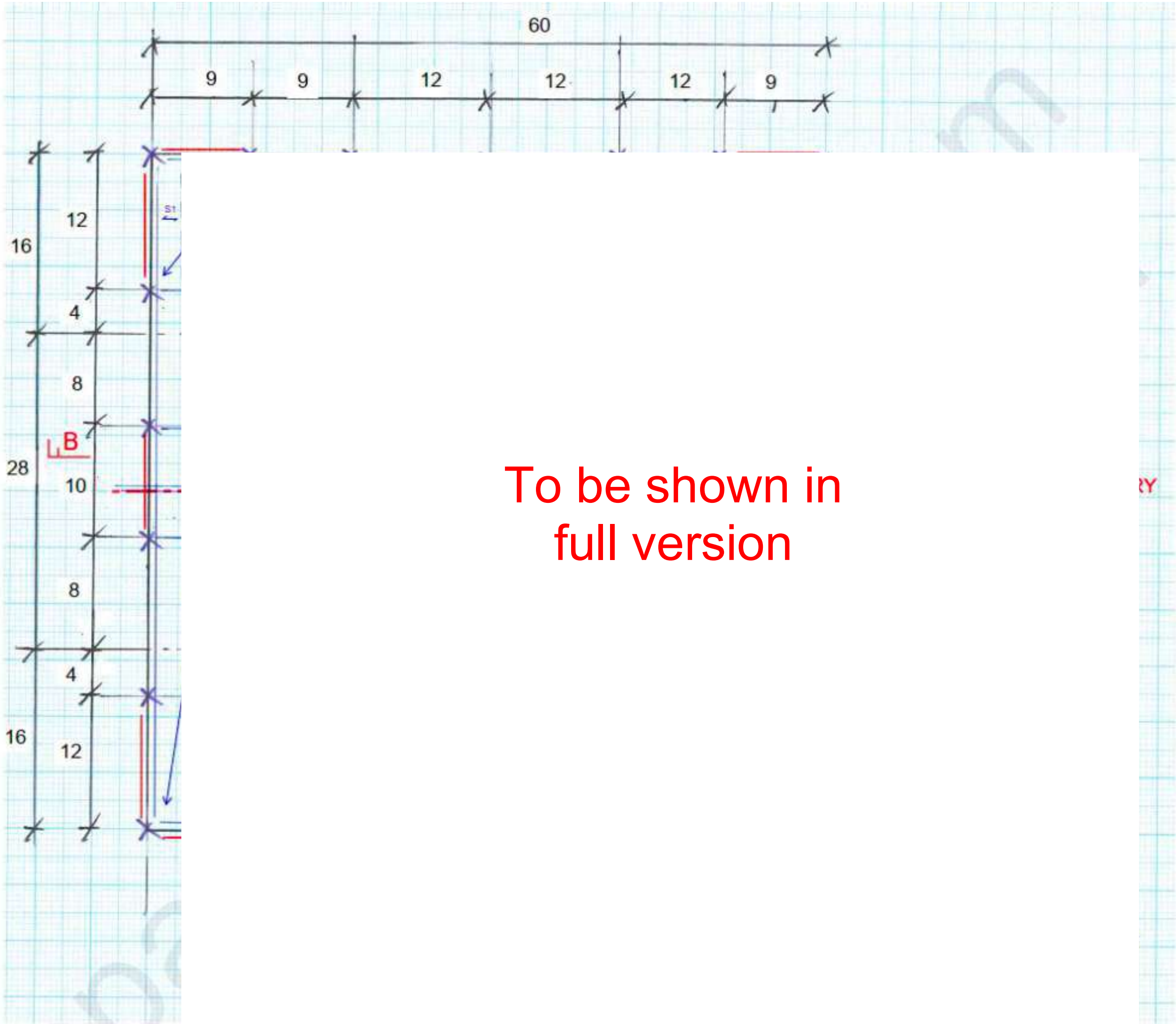
To be shown in full version

2.2 Sustainab

- Steel-concrete consumption
- Hierarchical be tonnage
- Prefabricated s

2.3 Functional Framing

(Use graph paper to draw)

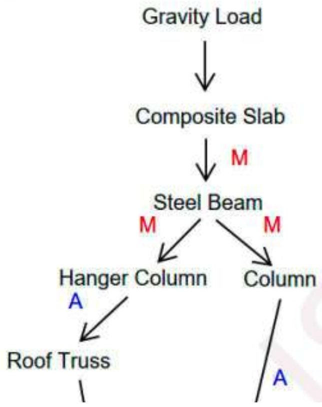


2.4 Load Transfer and Stability

1. Gravity Load

The gravity loads shall be supported by floor slabs, beams, columns and roof truss down to the foundations as figures below and load path described below.

Load Path



To be shown in full version

2. Lateral Load

Lateral stability is provided by the rigid beam column framework and core wall, down to the foundation.

Load Path

Wind Load

↓

External Cladding

↓

Floor Diaphragm

↓ Floor Diaphragm Action

Braced Core / Bay

SO

To be shown in full version

2.5 Feasibility Sizing and Calculations

(max. 12m x 12m grid with 2 x 2nd beam, load width = 4m)

DL =	7 kPa	Load width =	4 m
LL =	5 kPa		
w_{ULS} =	(1.4DL+1.6LL) x 4	w_{live} =	5 kPa x 4 m
=	71.2 kPa	=	20 kN/m

1. SB2 (254x254x167 kg/m UC – S355)

For deflec

I_{req}

$I_{prov.}$

2. SB1 (305x

Live loac

ULS load

For deflec

I_{req}

$I_{prov.}$

To be shown in full version

3. Column SC1 (356x406x634kg/m UC – S355)

Assume 7kPa DL and 5kPa LL per floor,

Storey = 7
Tributary Area = 12 m x 12m
Load = (7 x 1.4 + 5 x 1.6) x (12 x 12) x 7 storeys
= 18950 kN

Use 356x406x634kg/m UC – S355,
Axial Capacity = 26244 kN > 18950 kN, OK!

4. Hanger Co

Assume 7

Tributa

Use 356x
Axial C

To be shown in full version

5. Roof Truss

Flo

M

Use 356x
Compress

Total
Deflec

2.6 Other Considerations

1. Fire prc
   fire pro
2. Steel m
3. Vibratic
   detailec

2.7 Baseme

1. Constructio

A permanent s
temporary exc

Construction s
(1) Install soldi
(2) Carry out e
(3) Cast pile ca
(4) Pile cap to

To be shown in full version

2. Structural S

Pile Cap / Bas
lateral earth pr

Since the later
unbalanced so
foundation des

2.8 Foundation Scheme

Ground Condit

Scheme 2: So

Socketed Stee

- Weak
- SHP
- Rock

1. Load P

To be shown in
full version

2. Feasibi

Allow

) kN

Use 305x305

)0kPa)

Lateral l

SCHEME RECOMMENDATIONS

Scheme 1	Scheme 2
R.C. Structure	Structural Steel

To be shown in full version

Based on the a

SECTION 1 (B) – LETTER

LOGICAL T

Add basement

Impli \	
Exa	
De:	
Const	
Ti	
Co	
Solu	

To be shown in full version

LETTER REFERENCE

<Client's Addr

Dear <Client>,

RE: <Project r

Further to you
our comment

- Additional
- Total loadi
  required.
- Increase in

To accommod
including the s

To accommod
remain the sar
diameter and a

To accommod
and permanen
be required.

Please be aw

Constr
1. Extend
2. More te
3. Water
4. Extra m

Cost In
1. Constr
   works
2. Founda
3. Additio

To be shown in full version

Time Implications

1. Additional time will be required for designing the basement extension and statutory submis
2. Additio extensi
3. Constru founda

Please let us k
we have inforn

Yours sincerel

<My signature
<My name prir
Cc. Architect, (

To be shown in
full version

SECTION 2 (C) – DESIGN CALCULATIONS

INTRODUC

The following e

1. Typical
    a.
    b.
    c.
2. Transfe
3. Columr
4. Screen
5. Wind S
6. Bored I

Assumption

1. Critical load
2. Actual defle
stage.

Design Codes

1. CoP for stru
2. CoP for four
3. BS 6399-2:

Design Data

Concrete C45

Den

Loading

Us

R

Office/(

Shops/Conco

Therefore, use

Cover (mm) –

Elen

Sl

Be

Columr

Oth

To be shown in full version

1. SLAB (175 MM THK.)

Span 3.33 m max. between primary / secondary beams

LOAD

S/W =

SDL =

LL =

w_{ULS} = 1

BENDING

M =

d =

k =

z =

As, req =

Provide

As, prov =

SHEAR (* p

V = v

v = \

v_c = (

\

DEFLECTIO

CARBON C/

1. Quantities

- Mass of C(
- Rebar: Ass

Mass of R(

2. Carbon F

- Concrete: (
- Rebar: 1.9

3. Carbon E

- Concrete: (
- Rebar: 0.0

Total Quanti

To be shown in full version

2. MAIN BEAM (1000 X 800 DP.)

Span 10 m between columns

LOAD (No. c

S/W =

P_{DL} = L

P_{LL} = L

BENDING

M =

d =

k =

z =

As, req =

Provide

As, prov =

SHEAR (* p

V =

v =

vc =

0.5

Prc

DEFLECTIO

L/d =

CARBON C/

1. Quantities

- Mass of C(

- Rebar: Ass

Mass of R(

2. Carbon F

- Concrete: (

- Rebar: 1.9

3. Carbon E

- Concrete:

- Rebar: 0.1

Total Quantities = 0.230 + 0.287 = 0.517 tCO_2/e / m beam

To be shown in full version

3. CANTILEVER BEAM CB1 (1000 X 800 DP.)

Span 3 m from column

LOAD

S/W =
P_{DL} = l
P_{LL} = l

BENDING

M =
d =
k =
z =
As, req =
Provide
As, prov =

SHEAR (* p
V =
v =
vc =

0.5
As/

Prc

DEFLECTIO
L/d =

CARBON C/

1. Quantities
- Mass of Co
- Rebar: Ass
  Mass of Re

2. Carbon F
- Concrete:
- Rebar: 1.9

3. Carbon E
- Concrete:
- Rebar: 0.1

To be shown in full version

Total Quantities = 0.230 + 0.287 = 0.517 tCO_2e / m beam

4. TRANSFER BEAM TB1 (3000 X 2500 DP.)

Span 25 m between columns

LOAD

From Part A

BENDING

d =

k =

z =

As, req =

Provide

As, prov =

SHEAR (* p

v =

vc =

0.5

As/

Prc

DEFLECTIO

L/d =

CARBON C/

1. Quantities

- Mass of Co
- Rebar: Ass
  Mass of Re

2. Carbon F

- Concrete:
- Rebar: 1.9

3. Carbon E

- Concrete:
- Rebar: 3 t/

Total Quanti

To be shown in full version

5. COLUMN (1000 X 1000)

CARBON C

1. Quantities
- Mass of C
- Rebar: Ass
  Mass of R

2. Carbon F
- Concrete:
- Rebar: 1.9

3. Carbon E
- Concrete:
- Rebar: 0.2

Total Quanti

To be shown in full version

6. SCREEN WALL (400 MM THK.)

Span 5 m max. between floor diaphragm

In accordanc

LOAD

1. Su

2. S

To be shown in full version

BENDING

M =

d =

k =

z =

$A_{s,req}$ =

Provide

$A_{s,prov}$ =

Service Str

SHEAR

V = 1

v = \

vc =

\

CARBON CALCULATIONS per meter run (formwork ignored)

1. Quantities
- Mass of Co
- Rebar: Ass
Mass of Re

2. Carbon F
- Concrete:
- Rebar: 1.9

3. Carbon E
- Concrete:
- Rebar: 0.0

Total Quanti

To be shown in
full version

7. WIND LOAD ESTIMATION AND SHEAR WALL (300 MM THK.)

For BS 6399

Assume bu
(Equ 9; ass

In conserva

The site loca
The closest

Tot

Basic
Len

To be shown in
full version

In x-direction wind load will be resisted by two shear cores and it is more critical.
Assume 70% of lateral load taken by cores, loading for each core

M = 0
= 0
=

V = 0
= 0
=

2 walls in x-c

CHECK SH

CHECK AX

ULS: axial l

To be shown in full version

A

Capacity = 0.87 fy Ast = 0.87 x 500 x 2.2% x (1000 x 300)
= 3190 kN/m **OK!**

Building Deflection to fulfill H/500 to be checked in detailed design stage.

8. BORED PILE BP (Φ 1500 MM WITH BELL-OUT)

Checking Re

As Shear fc
Detailed ch

Design to C

Allowab

F

To be shown in
full version

Wind Axial

Win

Pile
Lo

Pile Capa

Consider the

SECTION 2 (D) – DESIGN DRAWINGS

GENERAL

1. ALL I
2. ALL (
3. ALL I
4. MEM

TRANSI

BOR

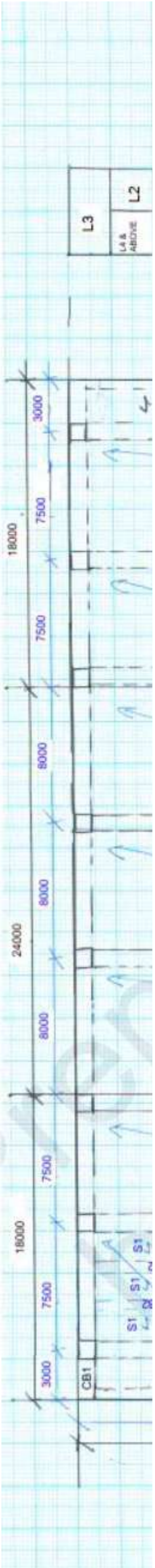
5. REIN

To be shown in full version

6. TENS
DIAM

FRAMING PLAN

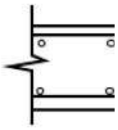
1. ALL FLOORS



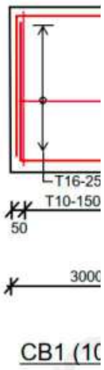
To be shown in full version

GENERAL DETAILS

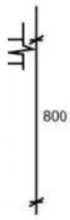
1. Slab Details



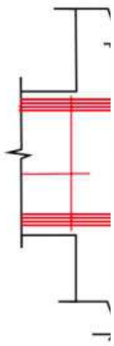
2. Mai



To be shown in full version



3. Transfer Beam Details



4. Colu

To be shown in full version

SECTION 2 (E) – METHOD STATEMENT & PROGRAMME

METHOD

Site Set-Up

1. Fenc
2. Carry

Site Survey

1. Carry unde comr
2. Setup vibra

Deep Found

1. Insta
2. Cons
3. Conc
4. Carry
5. Comi

Basement ai

1. Cons
2. Cons stren

Superstructu

1. Cons (i.e, f
2. For c R.C. caste of su
3. Comp
4. Carry

Site Clearan

1. Rem towe
2. Carry

To be shown in full version

CONSTRUCTION PROGRAMME

Construction Programme

To be shown in
full version

Good Luck & Thanks