



香港工程師學會

THE HONG KONG INSTITUTION OF ENGINEERS

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The HKIE Structural Examination – Written Examination

**Section 2: Design Questions
(80% of the Written Examination)**

Date: 11 December 2009 (Friday)

Time: 1:15 pm – 6:15 pm

Answer ONE question only

Question 1 Cable Equipment Building

Client's requirements

1. An equipment building is to be developed inside an existing cable station in Lantau; see Figure Q 1.
2. The building line of the equipment building has to be in line with the outer edge of the existing retaining wall.
3. For aesthetic reasons, the parapet wall above the roof has to be built solid and in compliance with the local regulations.
4. For equipment mobilization, the external wall along grid-line B may have to make large openings. The wall shall not be load-bearing. The columns, if any, along grid-line B have to be at minimum clear spacing of 2000 mm.
5. The equipment building has to be built (i) with good sound-proof material; (ii) at a most economical approach, (iii) in a shortest construction duration and (iv) with a FRP of 2 hours.
6. Equipment cables are laid in the trench reserve area which will be back-filled with suitable filling material.
7. In view of the tight dimensions of the building, the structural elements have to be arranged in such a way that the space utilization of the equipment building is optimized.
8. The existing cable station will remain in operation during construction of the equipment building.

Imposed loads

- | | |
|--------------|-----------------------|
| 9. Roof | 1.5kN/m ² |
| Ground floor | 10.0kN/m ² |

Site conditions

10. The site is located in the suburban area of Lantau near the sea at datum level of about 20.0mPD. Design wind pressure for the building has to be in accordance with the current local wind code.

11. Ground conditions as revealed by boreholes are :-

ground level (20.6mPD) – 17.3mPD	compacted fill
below 17.3mPD	completely decomposed granite with gravels and rock fragments. SPT N-value = 220

Ground water was encountered at 16.0mPD.

Omit from consideration

12. The existing retaining wall is an L-shape reinforced concrete cantilever wall with overall dimensions shown in Fig Q 1. The r.c. details and grade of concrete of the wall are not clear. Checking of the r.c. design of the wall is not required, but stability of the wall, if affected by the building, must be checked.

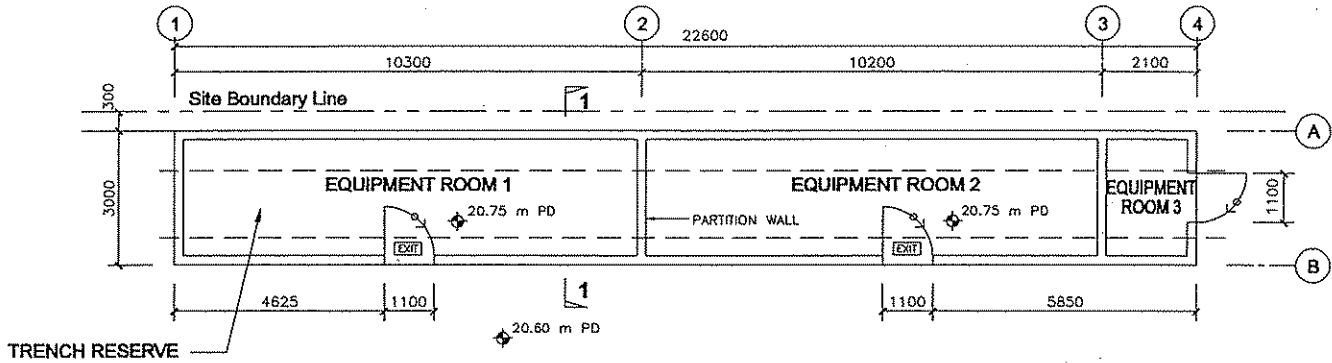
Section A

- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable schemes for the proposed structure including the foundation. Indicate clearly the functional framing, load transfer and stability aspects of the proposed and existing structures of each scheme. Identify the scheme you recommend, giving reasons for your choice. **(40 marks)**

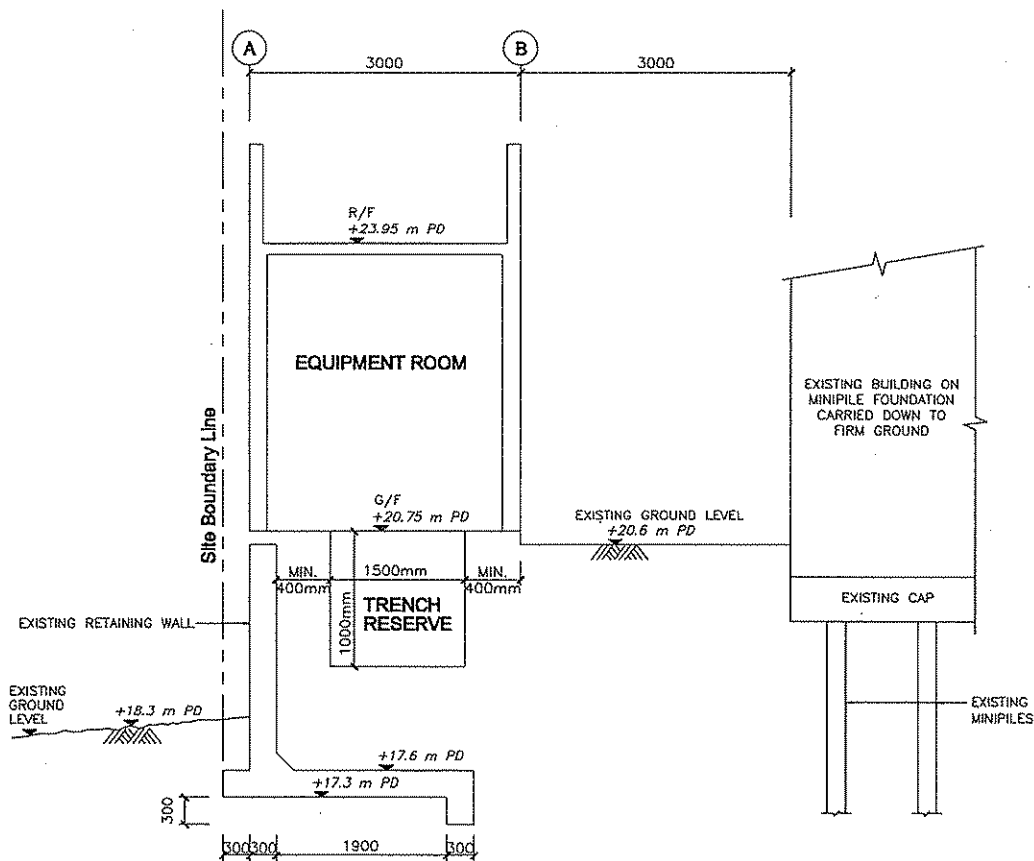
Section B

For the solution you recommended in (a)

- b. Prepare sufficient design calculations to establish the form and size of all the principal elements including the foundation. **(20 marks)**
- c. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details for estimation purposes. **(20 marks)**
- d. Prepare a detailed method statement for the safe construction of the structure including foundation. **(20 marks)**



PLAN



SECTION 1 - 1

NOTES:

1. ALL DIMENSIONS ARE IN mm
2. DOOR OPENINGS :- 2300mm (H) x 1100mm (W)

FIGURE Q1

Question 2 Aircraft Hangar

Client's requirements

1. An aircraft hangar with an attached 2-story office building is shown in Figure Q2. The elevations are to be clad with appropriate lightweight sheeting.
2. The aircraft requires a clear span of 45m and a clear height of 15m.
3. No internal columns are permitted.
4. The front of the hangar has to be column free so that aircrafts can be towed in and out of the hangar.
5. The roof is to be clad in metal decking.
6. The office should have a minimum ceiling height of 3m.
7. The top of the foundations should be at least 2m below the ground surface. This is to allow the laying of utility services within the site.
8. A minimum 2-hour fire resistance is required for all the structural elements.

Imposed loads

9. Hangar structure

Hangar roof	1.5kN/m ²
Loads from lifting appliances attached to the roof structure	5kN/m ²

Office structure

Roof	1.5kN/m ²
Upper office floor	5kN/m ²
Office ground floor	25kN/m ²

Loads given above include an allowance for partitions, finishes, services and ceilings.

Site conditions

10. The site is flat and is located in open country near the Hong Kong International Airport. Design wind pressure for the structures has to be in accordance with the current local wind code.
11. Ground conditions as revealed by boreholes are:-

ground level to 5m below ground - very loose and compressible loose fill,
range of SPT N-value ranges from 2 to 4.

5m to 8m below ground - very soft marine clay. SPT N-value ranges from
3 to 8.

8m to 15m below ground - alluvium, medium dense silt, SPT N-value ranges
from 12 to 15.

15m to 25m below ground - completely decomposed granite, dense to very
dense silty sand. SPT N-value ranges from 49
to 100.

25m below ground - slightly decomposed granite, total core recovery greater
than 85%.

Omit from consideration

12. Detail design of the hangar door, the staircases and elevators within the office building need not be given.

Section A

- a. Prepare a design study with appropriate sketches indicating two distinct and viable schemes for the proposed structure including the foundations. Candidates should indicate clearly the proposed framing schemes, the load transfer mechanisms and a check on the stability of the structure. Identify the solution you recommend to the client, giving reasons for your choice.

(40 marks)

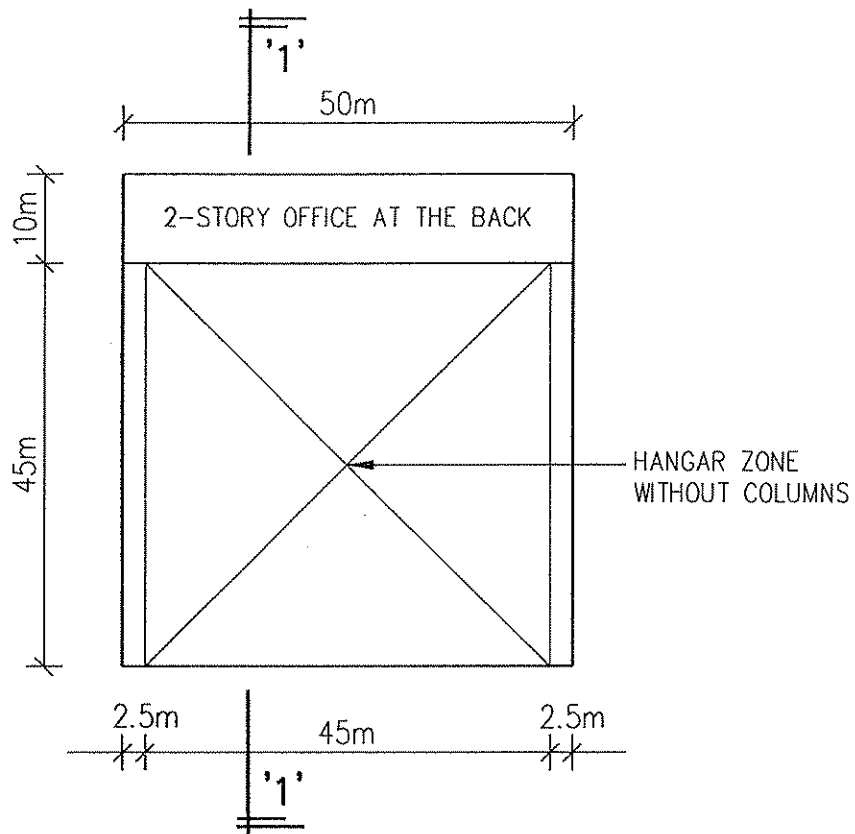
Section B

For the solution you recommended in (a)

- b. Prepare sufficient calculations to establish the size of all the principal structural elements including the foundations. **(20 marks)**

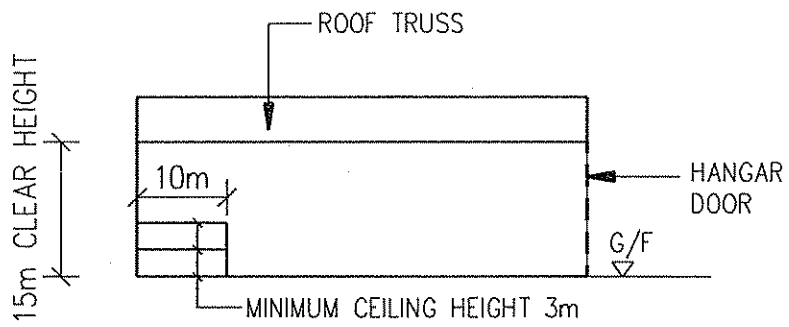
- c. Prepare framing plans, sections and elevations to show the dimensions; layout and disposition of the structural elements and critical details for estimating purposes. **(20 marks)**

- d. Prepare a simple method statement and programme for the safe construction of the structure. **(20 marks)**



G/F PLAN

(ALL DIMENSIONS SHOWN ARE IN METRES)



SECTION '1-1'

(ALL DIMENSIONS SHOWN ARE IN METRES)

FIGURE Q2

Question 3 Highway Bridge

Client's requirements

1. It is required to construct a new bridge connecting existing road network to a housing estate over a railway and two highway carriageways in the New Territories as shown in Figure Q 3.
2. The new bridge will carry a dual carriageway and footpath at both sides also as shown in Figure Q 3. As required by the Transport Department, the longitudinal gradient of the new bridge shall not exceed 1:15.
3. The bridge abutment walls at the eastern side of the highway envelope was built some years ago by the housing estate authority with due allowance to take care of the worst loading combinations from the new bridge. Hence, it can be assumed that this abutment wall can take any magnitude of horizontal and vertical loadings from the new bridge. However, concrete plinths/pedestals for supporting the bearings of the new bridge are required at the top of the abutment wall to suit your design. At the western side, bridge abutment retaining wall is required.
4. No temporary nor permanent work may be placed within the railway and highway envelopes.
5. The railway must remain in operation at all times except from 1:00am to 5:00am by special application to the relevant authorities to facilitate bridge construction. The two highway envelopes can be closed every day from midnight to 5:00am to allow for the bridge construction. Deck or parapet construction work may only be carried out above the railway and highway envelopes during their closure periods.

Imposed loads

- | | |
|---------------------------|---|
| 6. Vertical traffic loads | 10kN/m ² |
| Horizontal traffic loads | 1500kN, applied parallel to the carriageways across the full width of the bridge deck |
| Footpath load | 5kN/m ² |

Site conditions

7. The site is in the rural area. Basic wind speed is 46m/s based on a 3 second gust: the equivalent mean hourly wind speed is 23m/s.

8. Ground conditions as revealed by boreholes are:-

ground level to 12m below ground - decomposed rock, allowable bearing pressure
450kN/m².

more than 12m below ground level - sandy rock, allowable bearing pressure 1000 kN/m².

groundwater was encountered at 4m below ground level.

Omit from consideration

9. Design calculations for the western abutment retaining wall are not required.

Section A

a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable schemes for the proposed structure including the foundation and the western abutment retaining wall. The functioning framing, load transfer, safety and stability aspects of your schemes must be clearly indicated. Identify the solution you recommend, giving reasons for your choice. **(40 marks)**

Section B

For the solution you recommended in (a)

b. Prepare sufficient design calculations to establish the form and size of all main components including foundations. **(25 marks)**

c. Prepare general arrangement drawings including sufficient plans, elevations, sections etc. for the bridge structure excluding the western abutment retaining wall for quantity taking off purposes. **(20 marks)**

d. (i) Prepare clearly annotated sketches to illustrate the details of the concrete plinth/pedestal for supporting the bearings of the new bridge at the eastern abutment wall. **(7 marks)**

(ii) Prepare an outline programme for the construction of the new bridge including the western abutment retaining wall. **(8 marks)**

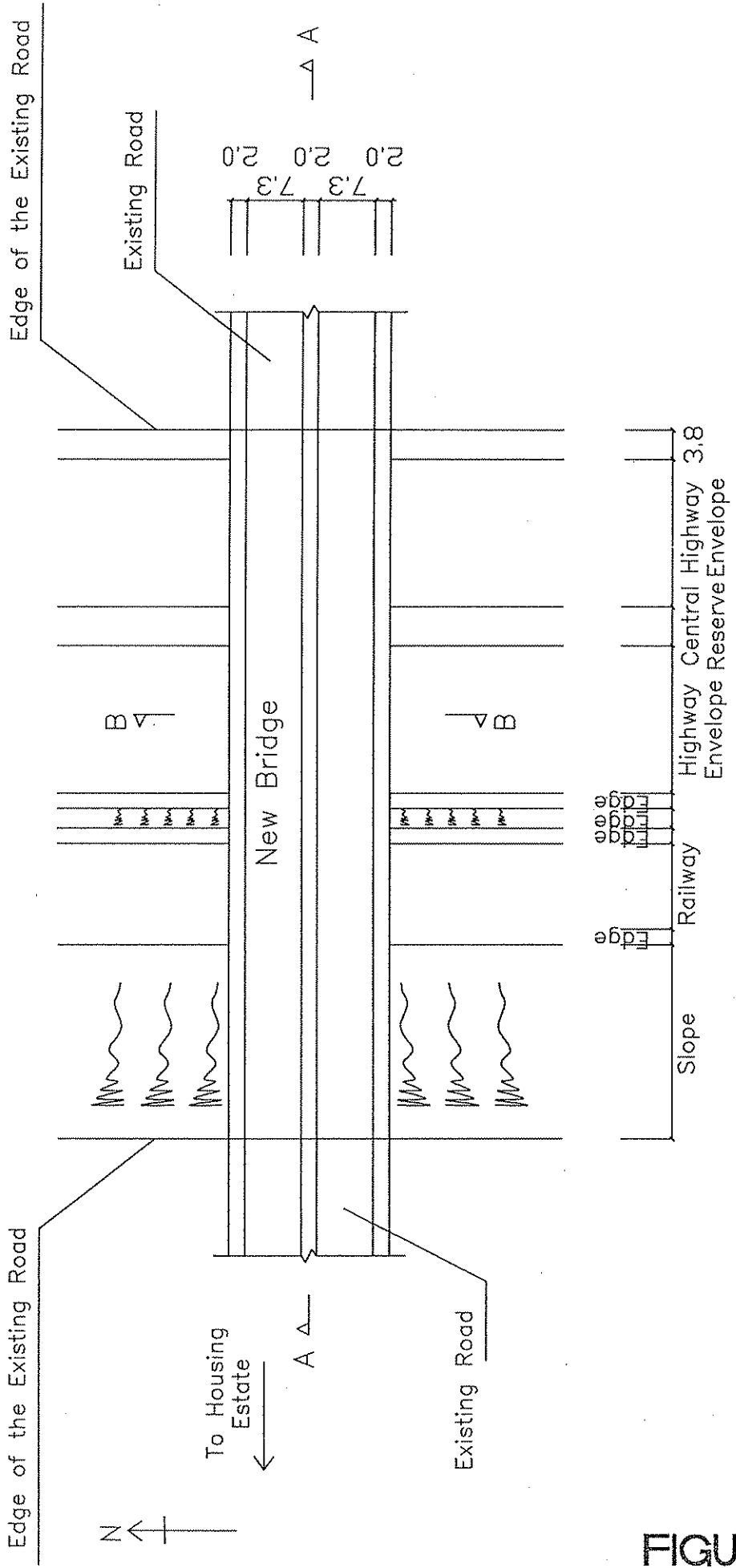
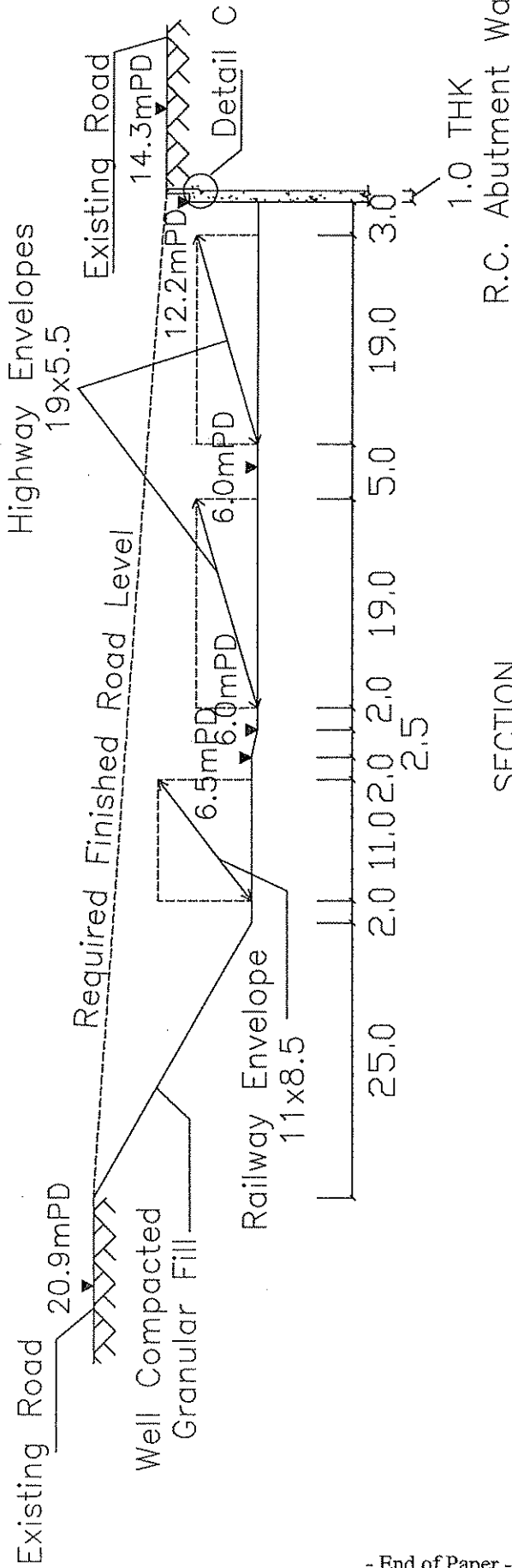
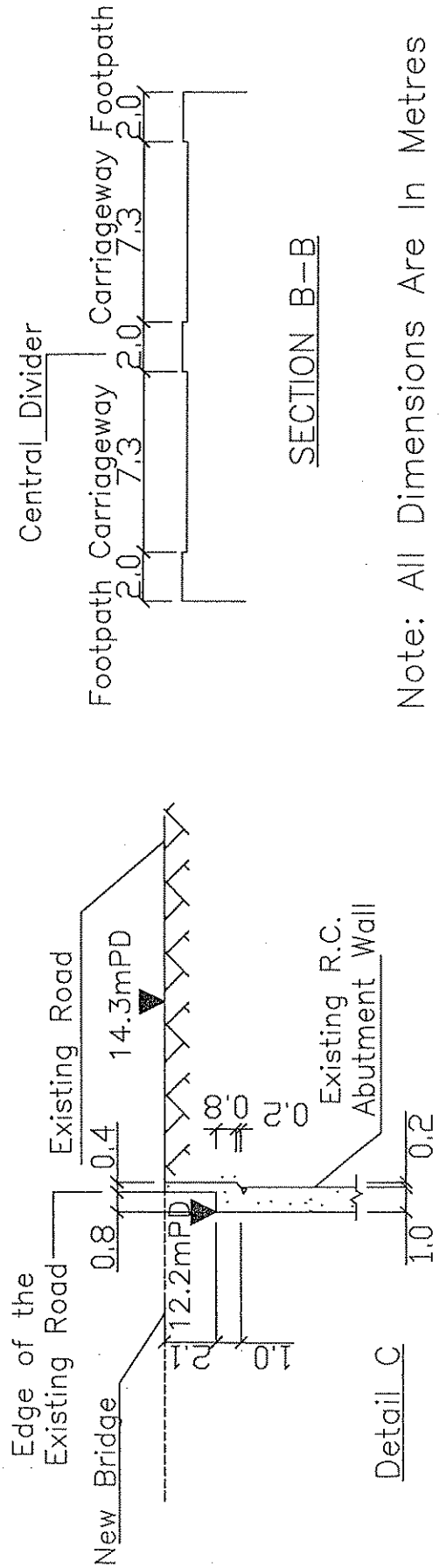


FIGURE Q3

To Housing Estate
←



SECTION A-A



Note: All Dimensions Are In Metres

FIGURE Q3