

Chartered Membership Examination

Thursday 28 April 2011

Structural Engineering Design and Practice

09.30 – 13.00 and 13.30 – 17.00 (Discussion between individuals is not permitted during lunch period). A period of fifteen minutes is provided for reading the question paper, immediately before the commencement of the examination. Candidates are not permitted to write in answer sheets, or on drawing paper or to use a calculator during this time. Candidates must satisfy the Examiners in ONE question.

Important

The written answer to the question selected and any A3 drawings must bear the candidate's number and the question number at the bottom of the page. Only the answer sheets supplied by the Institution may be used. The candidate's name should not appear anywhere in the script.

Notes to Candidates

1. TO PASS THE EXAMINATION, CANDIDATES MUST SATISFY THE EXAMINERS IN BOTH PARTS OF THE QUESTION ATTEMPTED.
2. Examiners will only mark work written by hand during the examination.
3. A fair proportion of marks will be awarded for the demonstration of an understanding of fundamental engineering concepts, as distinct from calculation of member forces and sizes. NOTE: In the calculation part of all questions, establishing "form and size" is taken to mean compliance with all relevant design criteria, i.e. bending, shear, deflection, etc.
4. In all questions 50 marks are allocated to Section 1 and 50 marks to Section 2.
5. The Examiners are looking for sound structural designs. It should also be remembered that aesthetics, economy and function are important in any competent engineering scheme.
6. Any assumptions made and the design data and criteria adopted must be stated.
7. Portable computers or programmable calculators may be used but sufficient calculations must be submitted to substantiate the design, and these should be set out as in practice.
8. Good clear drawings and sketches are required; they should show all salient and structural features to suitable scales and should incorporate adequate details.
9. Candidates will not be allowed to include any previously prepared calculations, notes, sketches, diagrams, computer output or other similar material in their answer sheets or A3 drawings. Any previously prepared information submitted by candidates will be ignored by the examiners.
10. Strictly no external electronic contact is allowed between a candidate and anyone outside the examination venue. Mobile phones must be switched off throughout the duration of the examination.
11. This paper is set in SI Units.

Now read 'Reminder' on page 3.

Chartered Membership Examination, a reminder from your Examiners

The work you are about to start has many features in common with other examinations which you have tackled successfully but it also has some which are unusual.

As in every examination you must follow carefully the NOTES FOR CANDIDATES set out for your guidance on the front cover of this paper; allocate the available time sensibly and set out your work in a logical and clear way.

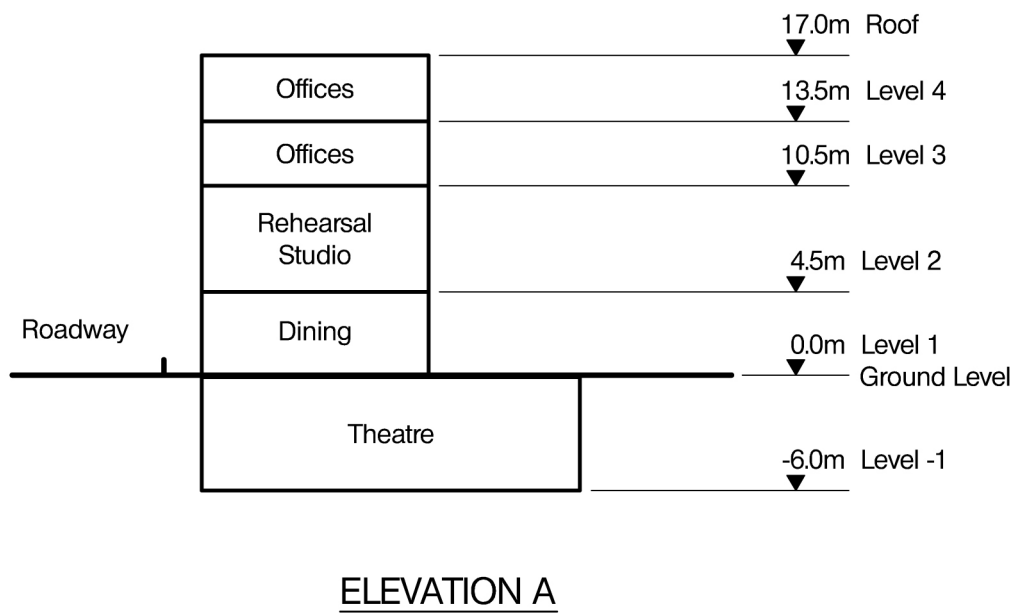
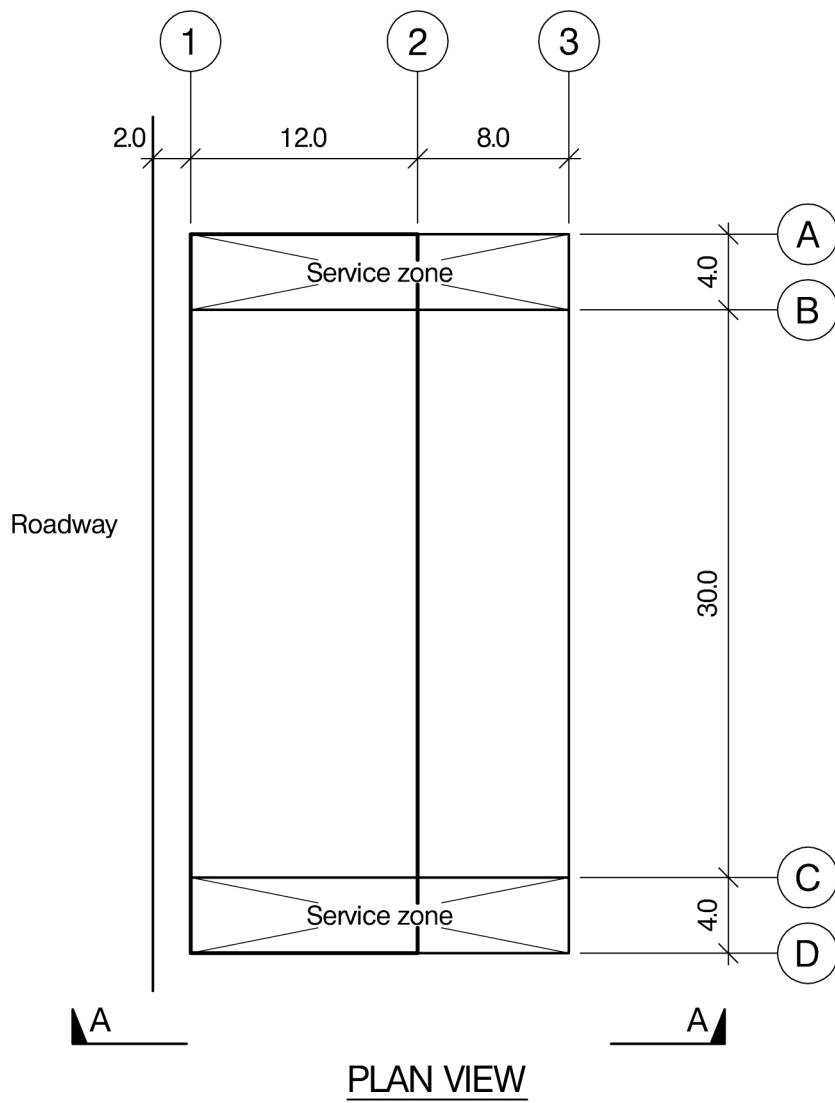
The unusual requirement of the examination is that you demonstrate the validity of the training and experience that you have acquired in recent years. The Institution must be satisfied that you are able to bring all the various skills you are expected to possess to the effective solution of structural design problems – whether or not the problem is presented in terms that are within your actual experience.

Chartered Structural Engineers must have the ability to design and a facility to communicate their design intentions. Where you are required to list and discuss possible structural solutions you must show by brief, clear, logical and systematic presentation that you understand the general structural engineering principles involved.

In selecting and developing your design you should also remember the guidance given in the Institution's report, Aims of Structural Design, and in particular:

- (1) "the structure must be safe",
- (2) "a good design has certain typical features – simplicity, unity and necessity",
- (3) "the structure must fulfil its intended function".

If you have difficulty in deciding the correct interpretation of a question, pay particular attention to point 6. notes to candidates, on the front cover. The examiners will take into account your interpretation – and the design you base on this – if this is clearly stated at the beginning of your answer.



NOTE: All dimensions are in metres

FIGURE Q1

Question 1. Theatre

Client's Requirements

1. A new theatre and arts complex is to be built in a city centre: see Fig. Q1. The theatre is to be located below ground level with practice facilities, office space and eating facilities above.
2. A clear space must be provided within the performance area of the theatre bounded by gridlines 1 and 3 and gridlines B and C. No permanent structure may be provided in this space. At either end of the theatre space there is a service zone where there are no structural restrictions. Access for maintenance must be provided to all parts of each zone.
3. Above the theatre is an internal/external dining space at elevation +0.0m. The architect has specified that the only structural elements permissible on grid line 2 between gridlines B and C are slender columns. No bracing or walls are permitted.
4. A double storey rehearsal studio is at elevation +4.5m. The area available for rehearsal shall be maximised by limiting columns to a minimum. Two floors of offices are located above the rehearsal space where there are no specific restrictions on structure.
5. The architect wants to allow as much light as possible into the building on Gridline 2 and has stipulated that more than 70% of the elevation shall be glazed between gridlines B and C.

Imposed Loading

- | | |
|-----------------|--|
| 6. Roof | 1.5 kN/m ² |
| Floor loading | Ground and theatre floors – 10.0 kN/m ² |
| Elevated floors | 5.0 kN/m ² |

Loadings include an allowance for partitions, finishes, services and ceilings.

Site Conditions

7. The site is level and located next to a busy road. Excavations may not approach the road closer than 1.0m. Basic wind speed is 40m/s based on a 3 second gust; the equivalent mean hourly wind speed is 20m/s.
8. Ground conditions – The site is level and the single borehole at the centre of the building is representative of the whole site. Ground water was found at -4.0 m

Borehole 1	Ground – 3.0m	Made ground
	3.0 m – 8.0 m	Stiff clay. C = 80 kN/m ² Ø=0
	Below 8.0 m	Rock. Allowable bearing pressure = 800 kN/m ²

Omit from consideration

9. Detailed design of stairs.

SECTION 1

(50 marks)

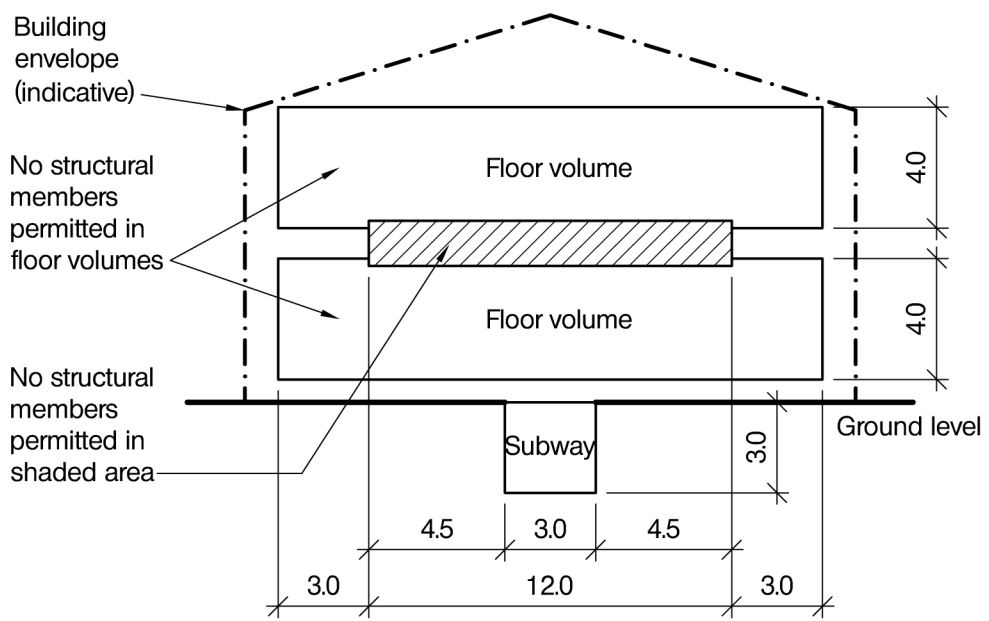
- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. After the design has been completed, the client advises that the rehearsal studio is to be column free internally. Write a letter to the client explaining what impact there will be on the design and how this might be achieved. (10 marks)

SECTION 2

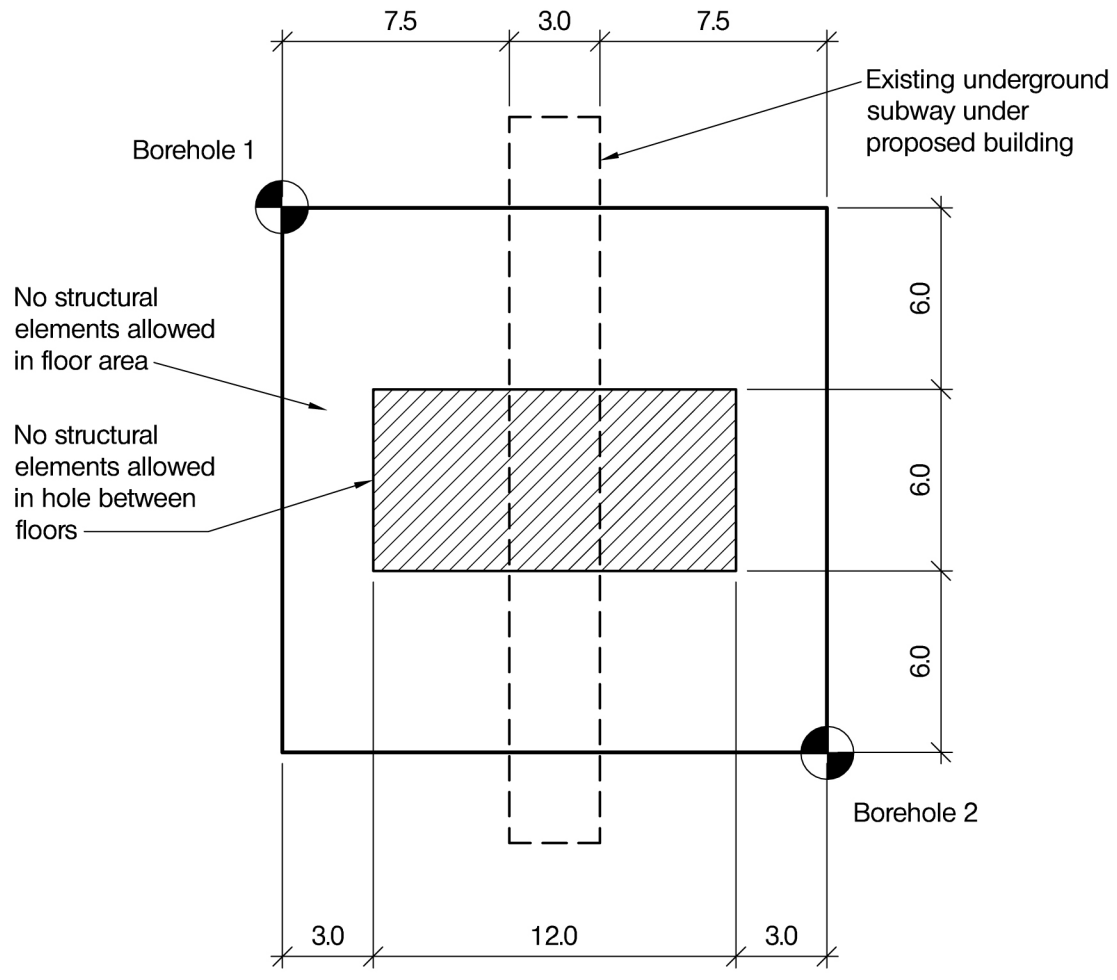
(50 marks)

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 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 details of any temporary propping of the structure required above ground level during construction. (10 marks)



SECTION



PLAN

NOTE: All dimensions are in metres

FIGURE Q2

Question 2. Exhibition Centre

Client's Requirements

1. A two-storey building to house a new exhibition: see Fig Q2. The exterior walls are to be of brickwork and the roof is to be clad with concrete tiles.
2. Each floor consists of a rectangular space 18.0m long by 18.0m wide. The clear floor to ceiling height of each floor is to be 4.0m. No structural members are permitted within these spaces.
3. There is to be a hole between the floors at the centre of each floor 6.0m long by 12.0m wide. No structural members are permitted in this hole.
4. There are no restrictions on the structural depth of each floor or on the structure outside the floor space.
5. An existing pedestrian subway 3.0m wide runs under the full length of the proposed building. The base of the sub-way is 3.0m below ground level. No additional loads must be imposed on the roof or walls of this subway.
6. Access to the upper floor is via an independent link not structurally connected to the Exhibition Centre.

Imposed Loading

- | | |
|-----------------|----------------------|
| 7. Roof loading | 0.5kN/m ² |
| Floor loading | 5.0kN/m ² |

Site Conditions

8. The site is located in a town centre. Basic wind speed is 46m/s based on a 3 second gust; the equivalent mean hourly wind speed is 23m/s.
9. Borehole 1

Ground level – 0.5m	Top soil
0.5m – 6.0m	Stiff clay C = 150 kN/m ² Ø=0
No water was found	

Borehole 2 Ground level – 0.5m	Top soil
0.5m – 3.0m	Stiff clay C = 150 kN/m ² Ø=0
Below 3.0m Rock – allowable safe bearing pressure 500 kN/m ²	
No water was found	

Omit from consideration

10. Detailed design of staircases or lift shafts

SECTION 1

(50 marks)

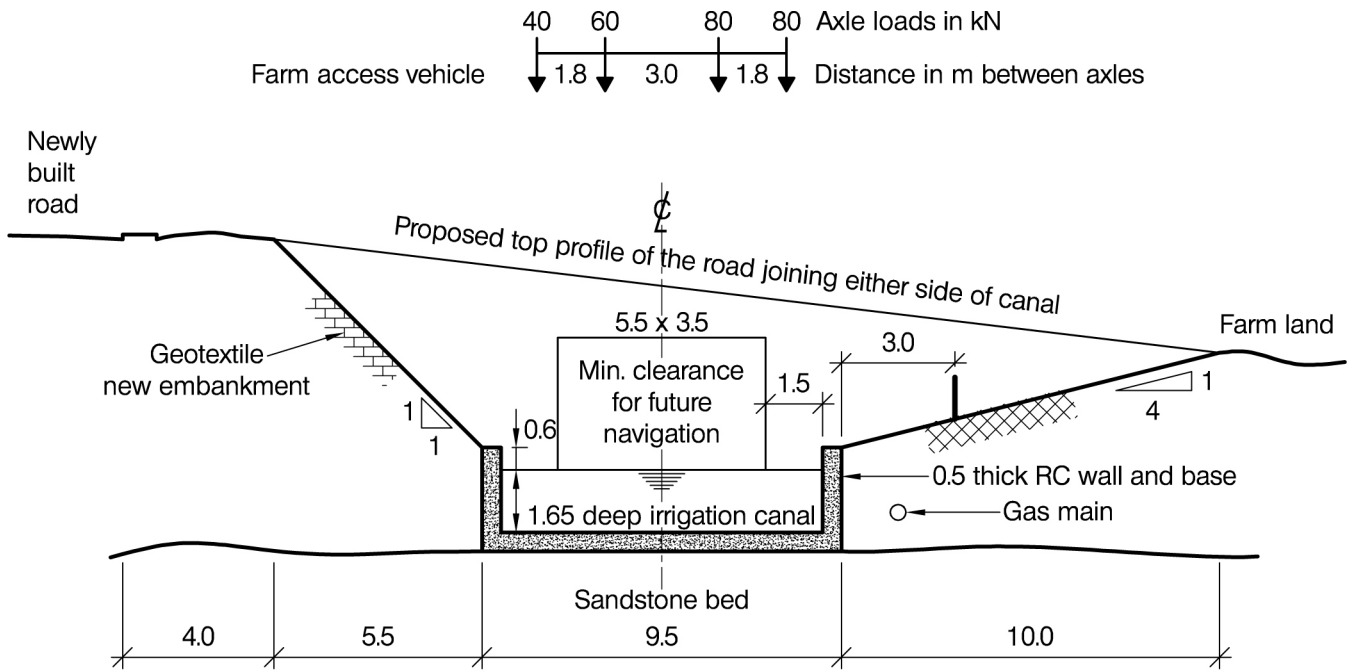
- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. After your design is complete, the client explains that he does not want a roof over the hole in the centre of the building. Write a letter to your client advising him of the implications of this change. (10 marks)

SECTION 2

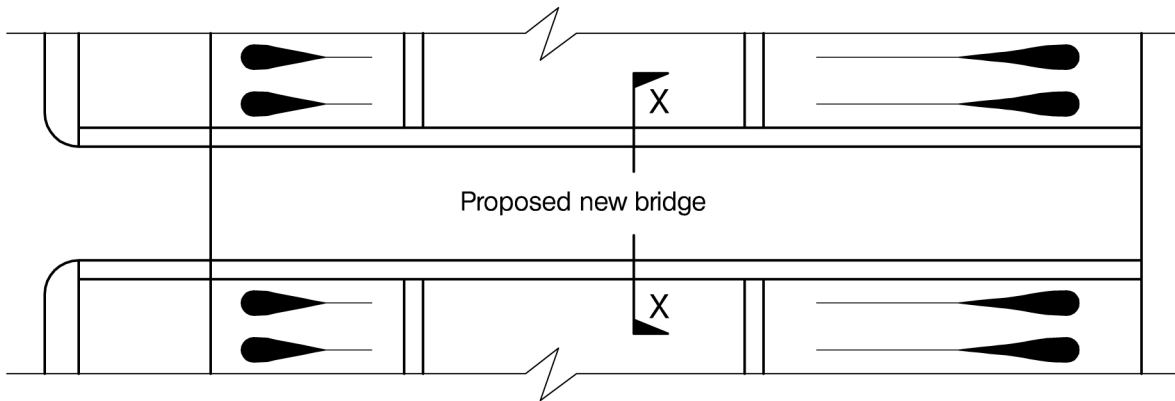
(50 marks)

For the solution recommended in Section 1(a):

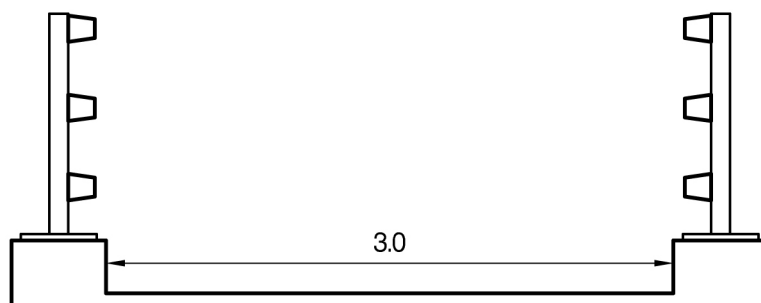
- c. Prepare sufficient design calculations to establish the form and size of all the principal structural elements including the foundations. (20 marks)
- d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements and critical details for estimating purposes. (20 marks)
- e. Prepare a detailed method statement for the safe construction of the building and an outline construction programme. (10 marks)



SECTIONAL VIEW OF CANAL AND ELEVATION OF PROPOSED BRIDGE



PLAN VIEW OF PROPOSED NEW BRIDGE



SECTION X-X

NOTE: All dimensions are in metres

FIGURE Q3

Question 3. Farm Access Bridge

Client's Requirements

1. A private access bridge across a canal from a newly built road along the canal embankment to farm land on the opposite side. See Fig. Q3.
2. Transverse cross fall can be ignored. Navigational clearance as shown in Fig.Q3 must be maintained at all times. Unobstructed views along the canal are required from the bridge.
3. Because of an existing underground gas main, no new temporary or permanent works are permitted within 3.0m of the canal on the farm land side. The existing concrete canal walls can be used for support and have a maximum safe vertical working load capacity of 100kN/m.
4. The road and canal may not be closed for more than one weekend over a period of six months.

Imposed Loading

5. Farm vehicle load 260kN as detailed in Fig.Q3.
Uniformly distributed load 5.0kN/m²
The above loads do not occur simultaneously.

Site Conditions

6. The site is located in open countryside. Basic wind speed is 46m/s based on a 3 second gust; the equivalent mean hourly wind speed is 23m/s.
7. Ground conditions:

Road embankment	Granular fill, N=15
Farmland	Clay, C=40kN/m ²
Sandstone	Allowable bearing capacity 1000kN/m ²

No groundwater was encountered during ground investigation works.

Omit from consideration

8. Longitudinal imposed loading.

SECTION 1

(50 marks)

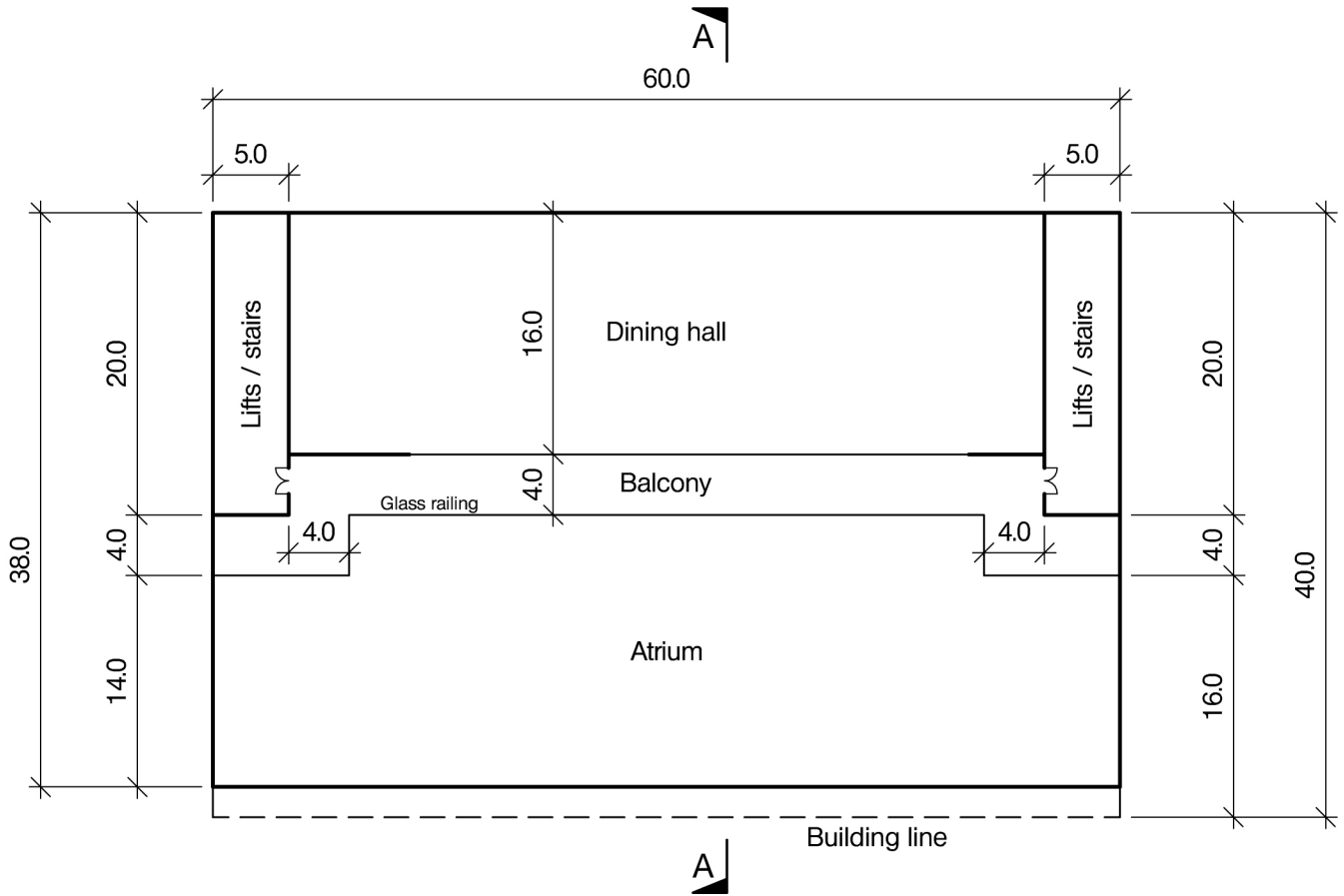
- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the bridge including its foundations. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. During design the client informs you that the water level in the canal can sometimes rise to 300mm below the top of the canal wall. Write a letter to the client advising him of the implications. (10 marks)

SECTION 2

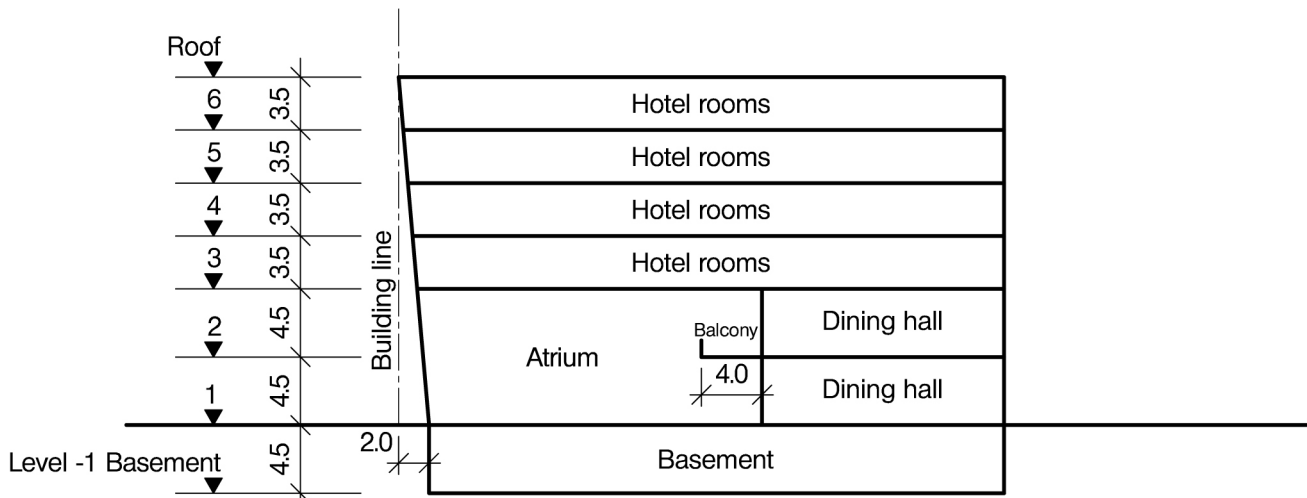
(50 marks)

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 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 bridge and an outline construction programme. (10 marks)



LEVEL 2 PLAN



SECTION A-A

NOTE: All dimensions are in metres

FIGURE Q4

Question 4. Hotel Building

Client's Requirements

1. A six-storey hotel with a basement in a town centre, see Figure Q4.
2. Lifts and staircases are to be located at the rear corners of the building as shown in Fig. Q4. Floor to floor dimensions are to be 4.5m for the basement and levels 1 and 2, and 3.5m for levels 3 to 6.
3. The floor at level 2 is to be set back from the front of the building to provide an atrium, and a 4.0m wide balcony is to be provided at this level as shown in Fig. Q4.
4. The front elevation of the building is to be glazed to provide maximum lighting to the interior and a 15m wide and 3.5m high door is required to this elevation.
The front of the building is inclined so that at ground level the façade is set back 2.0m from the site boundary. (See section A.)
5. Columns are not permitted in the atrium area. There are no other restrictions on column spacings.

Imposed Loading

- | | |
|--------------------------|----------------------|
| 6. Roof | 2.5kN/m ² |
| Basement, levels 1 and 2 | 5.0kN/m ² |
| Levels 3 to 6 | 3.0kN/m ² |

Site Conditions

7. The site is level and is located in a town centre. Basic wind speed is 46m/s based on a 3 second gust; the equivalent mean hourly wind speed is 23m/s.
8. Ground conditions:

Ground level to -5.0m	loose and compressible fill
-5.0m to -10.0m	silty sand and gravel N = 6, density = 1900kg/m ³ , $\phi = 35^\circ$
-10.0m to -16.0m	dense sands, N varies from 25 to 50
Below - 16.0m	rock allowable bearing capacity 1500kN/m ²

 Groundwater was encountered at -1.5m.

Omit from consideration

9. Detailed design of stair/lift cores.

SECTION 1

(50 marks)

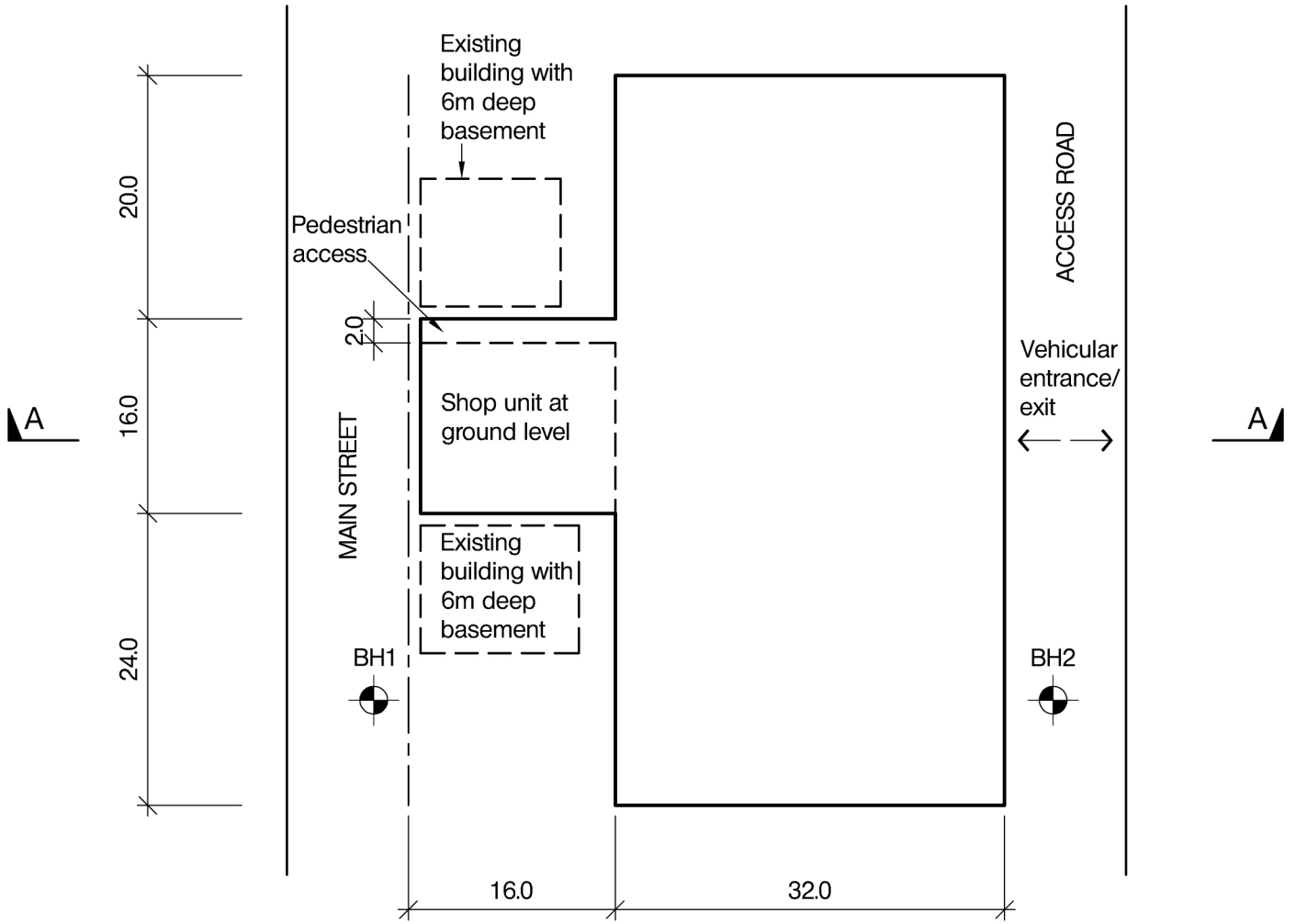
- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. After receiving your completed design, the client wants to second lower basement, with a floor to ceiling height of 4.5m, to the building for use as storage space. Write a letter to your client explaining the effect of this on your proposed design. (10 marks)

SECTION 2

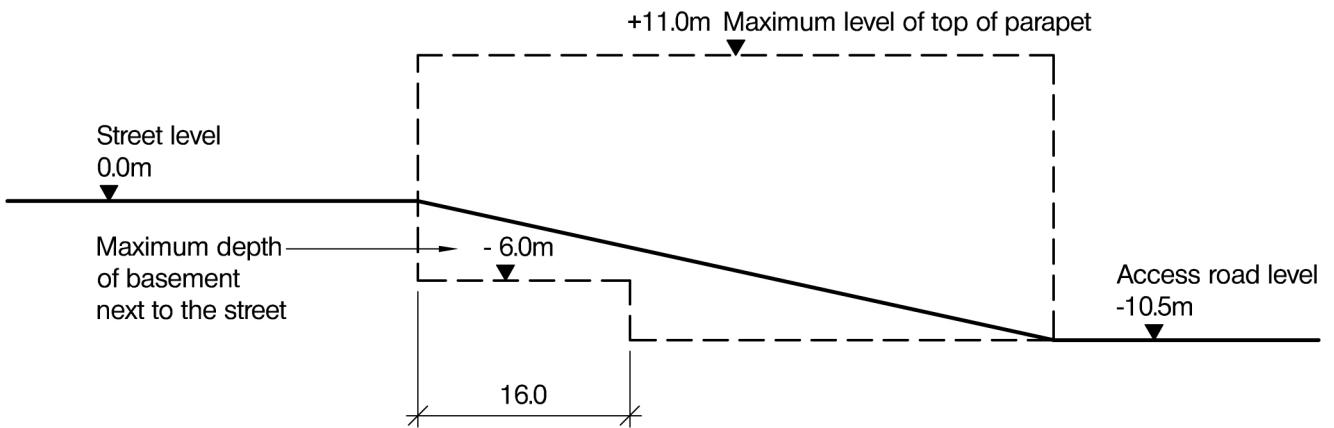
(50 marks)

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 foundations, superstructure and any significant retaining structures. (20 marks)
- d. Prepare general arrangement 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. (10 marks)



PLAN



SECTION A-A

NOTE: All dimensions are in metres

FIGURE Q5

Question 5. Town Centre Car Park

Client's Requirements

1. A new multi-storey car park next to the main street incorporating a shop unit at street level. See Fig. Q5.
2. The site slopes away from the main street. Vehicular entrance and exit are to be from the rear of the site. Pedestrian access is required from both the high street and from the rear of the site. The pedestrian access from the high street should be beside the shop unit. See Fig. Q5.
3. No more than one internal column is permitted in the shop unit.
4. A clear floor to soffit height of 3.0m is required to the shop unit and a clear floor to soffit height of 2.4m is required to the car park zones.
5. The top car park level is to be open with a 2.0m high parapet around the perimeter.
6. The number of car parking spaces should be maximised.
7. A minimum fire resistance period of 90 minutes is required for structural elements.

Imposed Loading

- | | |
|----------------|----------------------|
| 8. Shop unit | 5.0kN/m ² |
| Car park areas | 2.5kN/m ² |

Site Conditions

9. The site is located in a coastal area near the sea. Basic wind speed is 40m/s based on a 3 second gust; the equivalent mean hourly wind speed is 20m/s.
10. Ground conditions:

Borehole 1	
Ground level to -4.0m	made ground
-4.0m to -6.0m	sand and gravel N=10
Below -6.0m	sand and gravel N=40
Water encountered at 5.0m below ground level.	
Borehole 2	
Ground level to -0.5m	made ground
-0.5m to -3.0m	sand and gravel N=10
Below -3.0m	sand and gravel N=40
Water encountered at 2.0m below ground level.	

Omit from consideration

11. Detailed design of the lifts and staircases.

SECTION 1

(50 marks)

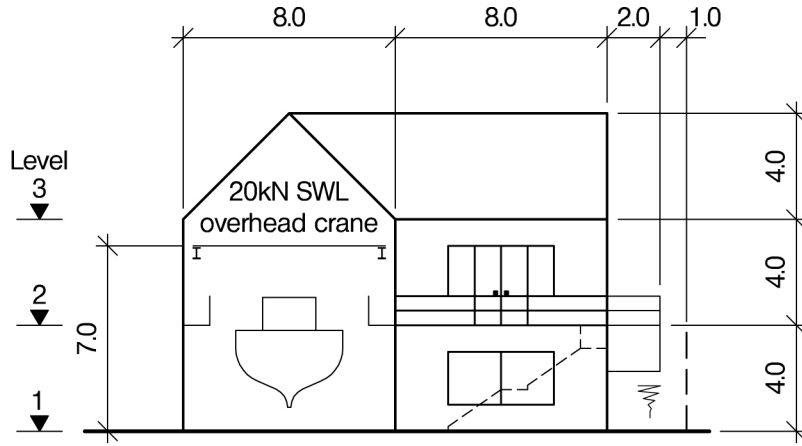
- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. After completion of scheme design, the client informs you that he wishes to increase the size of the shop unit by including a second level below the original unit. Write a letter to the client advising on the structural implications of this change and the effect on car parking capacity. (10 marks)

SECTION 2

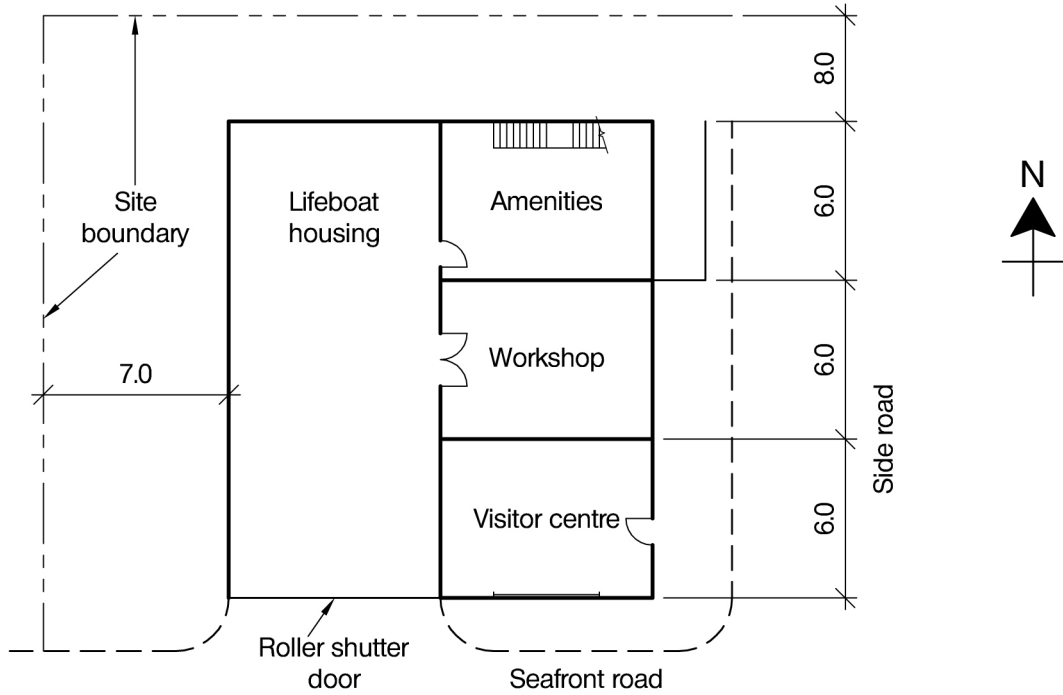
(50 marks)

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 foundations. (20 marks)
- d. Prepare general arrangement plans, sections and elevations to show the site layout, 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 car park and an outline construction programme. (10 marks)



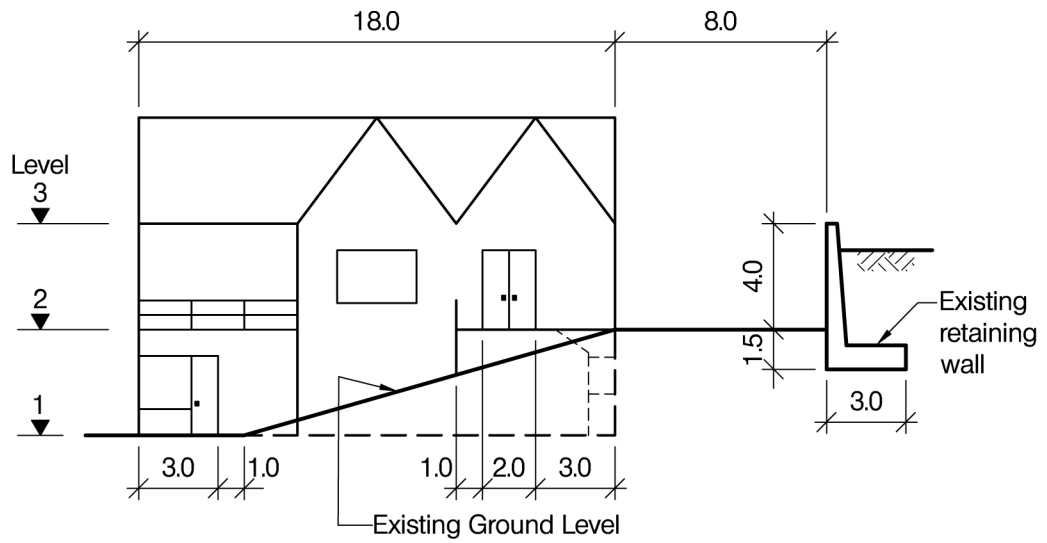
SOUTH ELEVATION



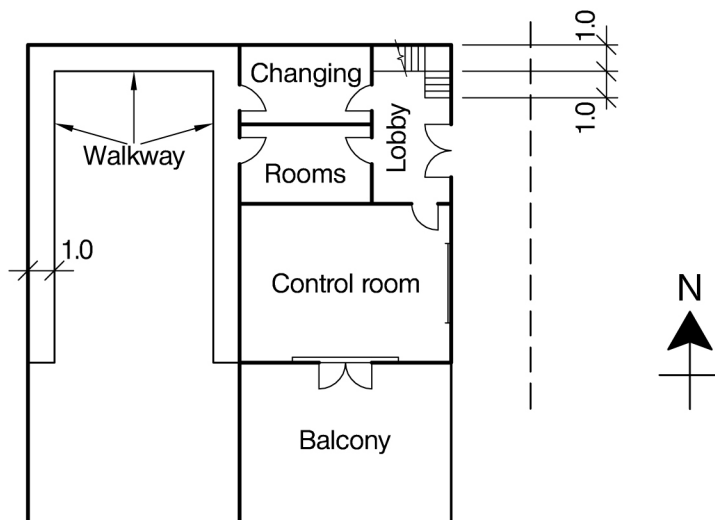
LEVEL 1 PLAN

NOTE: All dimensions are in metres

FIGURE Q6



EAST ELEVATION



LEVEL 2 PLAN

NOTE: All dimensions are in metres

FIGURE Q6 (continued)

Question 6 continued overleaf

Question 6. Lifeboat Station Building

Client's Requirements

1. A building for housing a lifeboat and towing tractor at Level 1 with an overhead crane over its length; as shown in Fig. Q6. At the Northeast corner there is a 1.0m wide staircase up to Level 2. From the pavement on the east side, a doorway at Level 2 provides access to a lobby, changing rooms and control room leading to a seafront balcony. A 1.0m walkway provides access from Level 2 changing rooms to the lifeboat. The south elevation to the lifeboat housing is to be glazed with an 8.0m high electrically operated roller shutter door.
2. The building is located in a corner plot 26.0m wide by 26.0m long with an existing retaining wall along the north and west boundaries and a public access road on the east and south sides. The retaining wall foundation is at 1.5m below existing ground level. The ground slopes in a North to South direction towards the seafront. Perimeter clearance is to be provided to the north and west sides of the proposed building as shown in Fig. Q6. A contractor's compound is available to the east of the side road.
3. Cladding to the roof and elevations is to be selected to minimise energy consumption and maintenance costs. A 1-hour minimum fire protection is required for all structural members.
4. Windows 2.0m high by 4.0m wide (double) or 3.0m high by 1.0m wide (single) and doors 3.0m high by 2.0m wide (double) or 3.0m high by 2.0m wide (single), are shown diagrammatically.

Imposed Loading

5. Pitched roof, Services 0.6 kN/m²
All floors 5.0 kN/m²
Crane capacity required: 20kN

Site Conditions

6. The site is 20m from the seafront slipway to the South.
Basic wind speed is 46 m/s based on a 3 second gust; the equivalent mean hourly wind speed is 23 m/s.
7. Ground conditions below ground level which follows the sloping ground:
Ground level to 0.5m Loose Clayey Sand. N = 4
0.5m to 5m Granular material N= 10 to 40 increasing with depth
Below 5m Very Stiff Clay C = 180 kN/m²
Ground water was noted at 4.0m below ground level.

Omit from consideration

8. Staircase design and the assessment of existing retaining walls but any precautions taken to safeguard their stability should be stated.

SECTION 1

(50 marks)

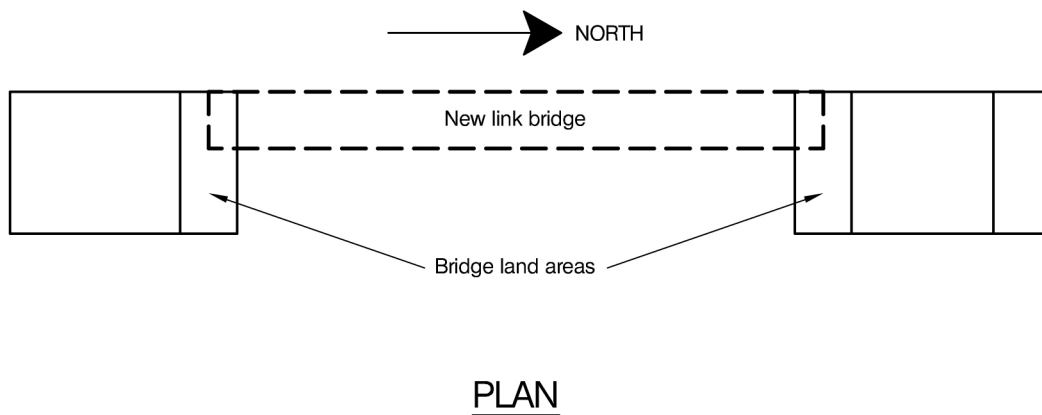
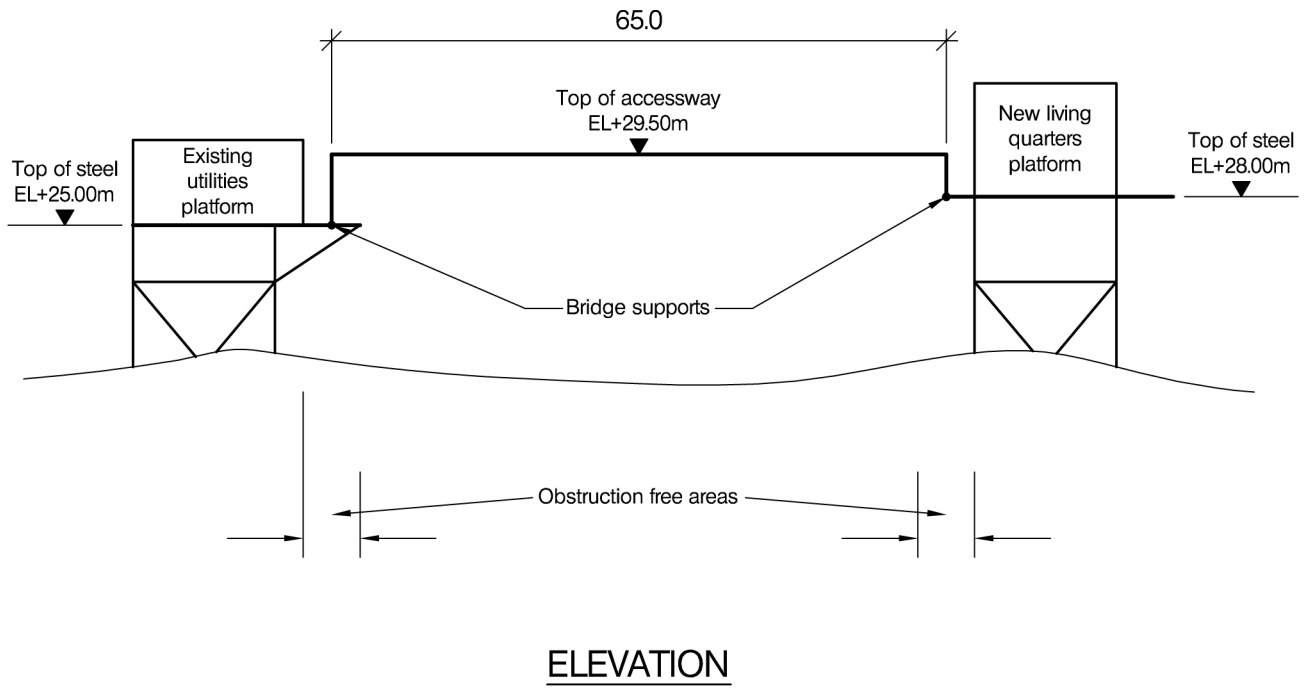
- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure including foundations. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. After completion of your design, the client asks for an extra 50 square metres of office space within the existing plan area of the building while keeping the balcony. Write a letter to your client explaining how this might be achieved advising the structural implications. (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 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 programme. (10 marks)



NOTE: All dimensions are in metres

FIGURE Q7

Question 7. New link bridge between two offshore platforms

Client's Requirements

1. A new bridge is to be installed offshore, linking an existing utilities platform with a new living quarters platform. The bridge is to be 65.0m long, and supported on the two platforms as shown in Figure Q7.
2. Bridge clearances at the existing platform are limited, so the new platform has been arranged to have adequate bridge clearance to accommodate the in-line relative movements of the platforms of +/- 500mm, caused by environmental loadings. Relative lateral displacement of the platforms is also +/-500mm. Due to the platform configurations, the supports at the north end of the bridge are at a different elevation to the south.
3. The bridge is to be fully enclosed, providing weather protection for a personnel access way and piping and electrical services. The access way is to be 1.5m wide by 2.5m high.
4. The bridge is to be transported to the offshore site by barge and lifted into place by a single crane lift vessel.

Imposed Loading

- | | |
|-------------------------|---|
| 5. Access way live load | 5.0kN/m ² (for personnel access only). |
| 6. Pipes | 10 No. 320mm OD pipes at 1kN/m length/each |
| 7. Cable Racks | 5No. 500mm wide x 150mm high racks at 0.5kN/m length/each |

Site Conditions

8. The basic wind speed is 60m/s, based on a 3 second gust; the equivalent mean hourly windspeed is 30m/s.

Omit from consideration

9. Fatigue calculations (but not the influence of fatigue on the bridge structure details).

SECTION 1

(50 marks)

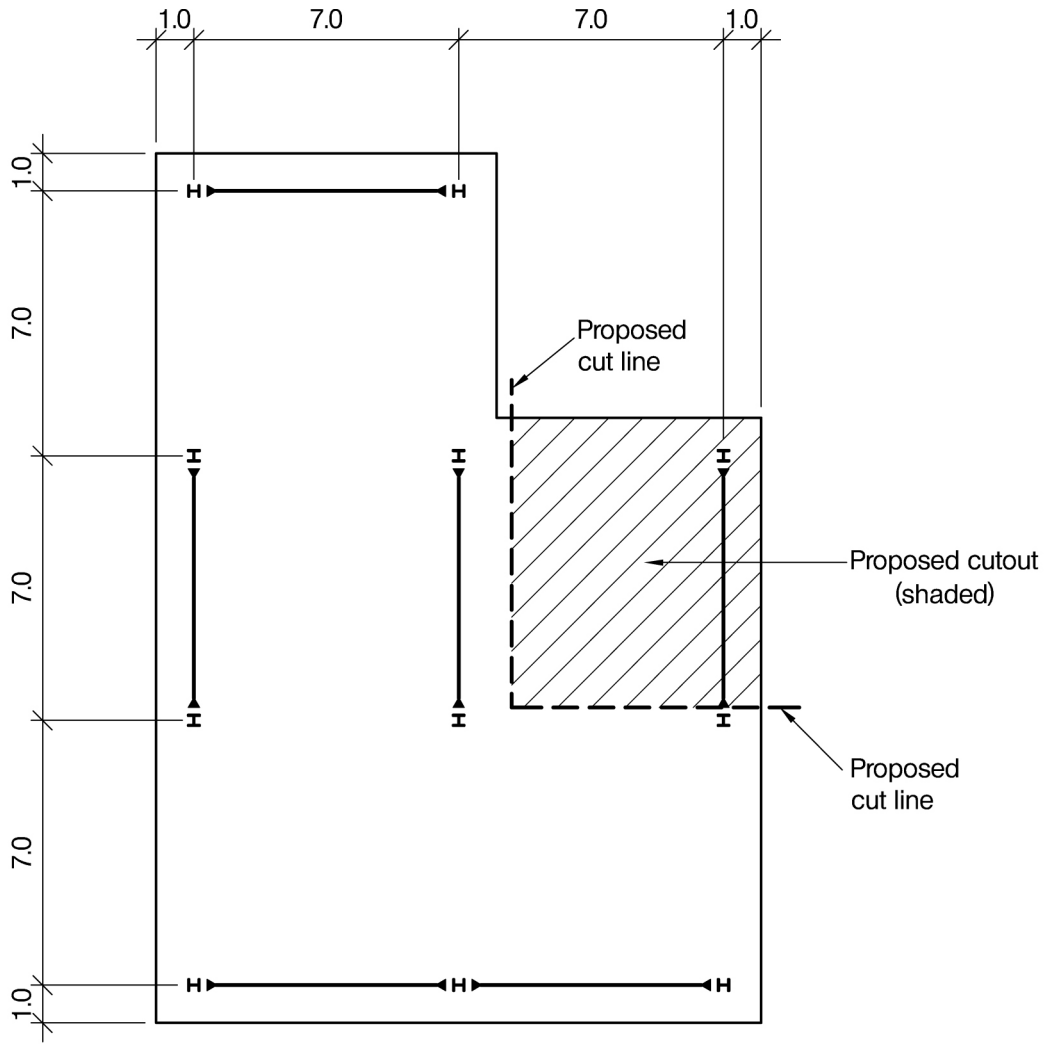
- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed bridge. Indicate clearly the functional framing, the support constraints, load transfer and stability aspects of each scheme for the relevant temporary and permanent design phases. Identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. After completion of your design, the client informs you that he wishes to incorporate a large laydown area, 10m x 10m, located on top of the bridge at the South end. The laydown area is to be used during platform operations and is to be designed for packages up to 4m high, and have a global uniformly distributed load of 5kN/m². Write a letter to the client explaining how this might be accomplished and the effects this would have on your chosen solution. (10 marks)

SECTION 2

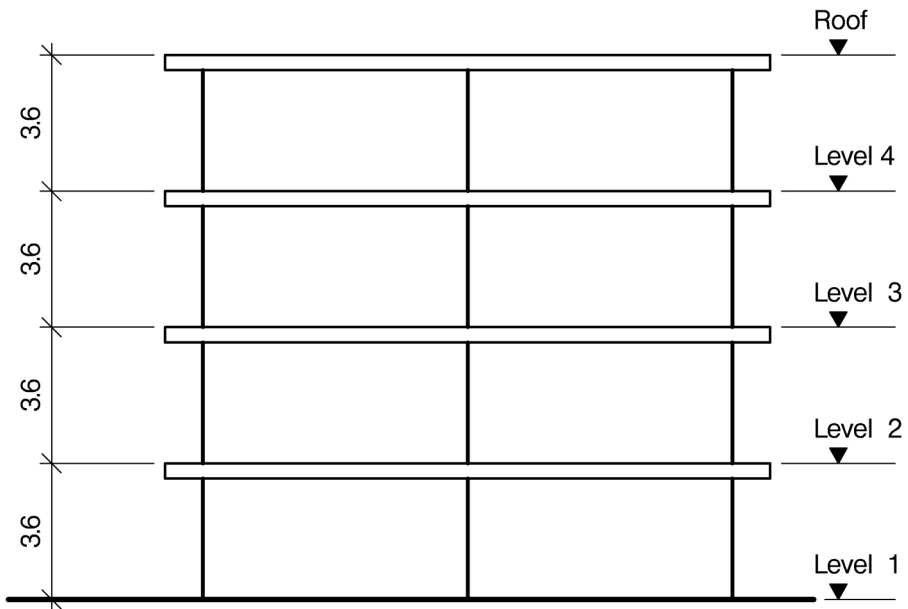
(50 marks)

For the solution recommended in Section 1(a):

- c. Prepare sufficient design calculations, for both the temporary and permanent conditions, to establish the form and size of all the principal structural elements and connections, including the support and lift points. (20 marks)
- d. Prepare general arrangement 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, including sketches, for the safe transport and installation of the bridge onto the existing platforms at the field location. (10 marks)



PLAN
FIGURE Q8-1



ELEVATION A-A
FIGURE Q8-2

NOTE: All dimensions are in metres

FIGURES Q8-1 and Q8-2

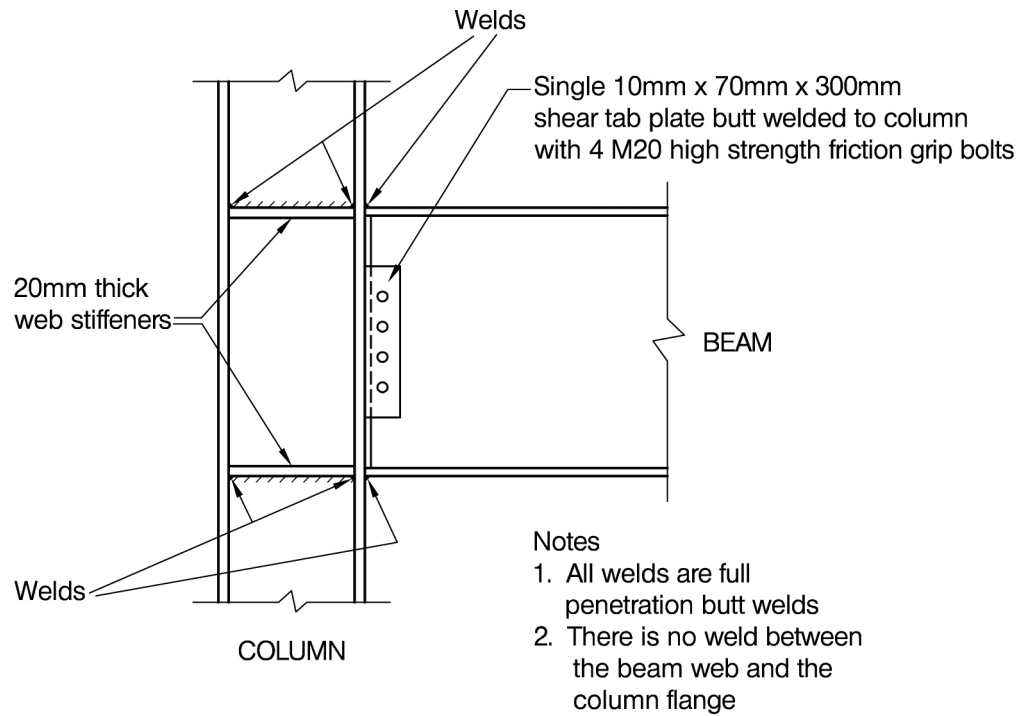


FIGURE Q8-3

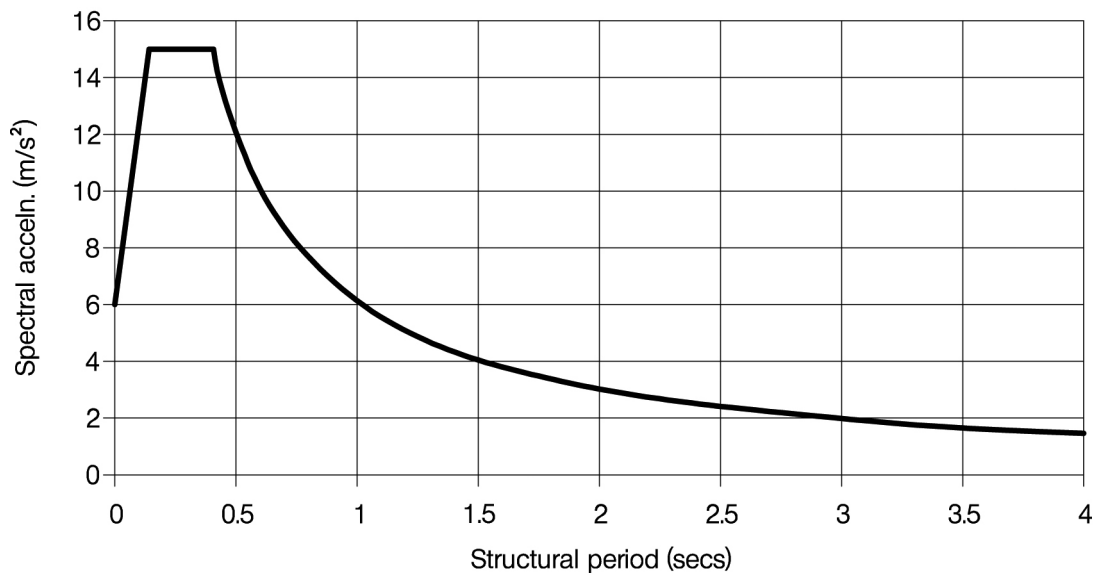


FIGURE Q8-4

Question 8. Office Retrofit

Client's Requirements

1. An existing office has been assessed and found to be substantially deficient and requires upgrading to meet new seismic provisions. The existing structure is an ordinary moment resisting frame (OMRF) structure.
2. The assessment has shown that the foundations are sufficient to resist the new seismic provisions and may be omitted from further consideration.
3. The building tenant requires unobstructed open spaces between the internal columns and a glazed elevation on the perimeter of the building.
4. The seismic upgrade is to be performed while the building is empty. Internal partitions and finishes have been removed to allow access to all structural members.
5. The plan of the building with existing moment frames is shown in Figure Q8-1. Figure Q8-2 gives the elevation of the structure and Figure Q8-3 provides the detail of the existing moment connection. The detail has been used throughout the building for all OMRF connections with simple shear tabs used elsewhere. All floor and roof slabs are 250 mm thick flat slabs with 16mm diameter bars at 150mm centres (characteristic yield strength of 400 N/mm²) each way each direction and are fully composite with the existing steel beams. The assessment of the slabs found that they were adequate to carry the existing vertical loads within the structure.
6. All beams are fabricated sections made from 200mm x 16mm flanges full strength welded to a 500mm x 10mm web. Columns are fabricated steel sections made from 300mm x 20mm flanges full strength welded to a 250mm x 16mm web. All fabricated steel has a characteristic yield strength of 275 N/mm².

Imposed Loading

7.

Roof	2.0 kN/m ²
Floor loading	All floors 3.0 kN/m ²
	1.5 kN/m ² allowance for partitions, finishes, service and ceilings load.
8. Figure Q8-4 shows the design 5% damped seismic response spectrum for the region. It applies to level ground for a 475 year return period, assuming the ground surface is rock with a shear wave velocity of not less than 800m/s.

Site Conditions

9. The site is level and located in the centre of a town.
Basic wind speed is 40m/s based on a 3 second gust; the equivalent mean hourly wind speed is 20m/s.

Omit from consideration

10. Detailed design of stairs. Foundations and ground conditions.

SECTION 1

(50 marks)

- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable retrofit solutions for the proposed structure. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. After the design has been completed, the client advises that the building is to be cut back for the top two floors along the cut out line shown in Figure Q8-1. Write a letter to the client explaining how this might be achieved and what impact there will be on the 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. (20 marks)
- d. Prepare general arrangement 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 retrofit and an outline construction programme, including details of any temporary propping required. (10 marks)

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