The Institution of Structural Engineers

Membership Examination Part 3

7 APRIL 1995

Structural Engineering Design and Practice

9.30 a.m. – 1 p.m. and 1.30 – 5 p.m. (Discussion between individuals is not permitted during the luncheon 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 books, 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 drawings must bear the candidate's index number and the question number in the bottom right-hand corner. Only the answer book(s) 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. 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, ie bending, shear, deflection, etc.
3. In all questions 40 marks are allocated to Part 1 and 60 marks to Part 2.
4. 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.
   Candidates should read carefully the examiners' reminder on Page 3.
5. Any assumptions made and the design data and criteria adopted must be stated.
6. Portable battery calculators may be used but sufficient calculations must be submitted to substantiate the design, and these should be set out as in practice.
7. Good clear drawings and sketches are required; they should show all salient and structural features to suitable scales and should incorporate adequate details.
8. This paper is set in SI Units, together with an alternative set of numerical data in British Imperial Units in parentheses. Candidates may use either set of data and may work in either system of units but should note that the two sets of data do not necessarily correspond. This is in order to avoid complicated arithmetic in one set of units.

Now read 'Reminder' on Page 3 ☞

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 clear and logical way.

The unusual requirement of the examination is that you must 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 a structural design problem – whether or not the problem is presented in terms that are within your actual experience.

A Chartered Structural Engineer must have an ability to design and a facility to communicate his 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 design principles involved.

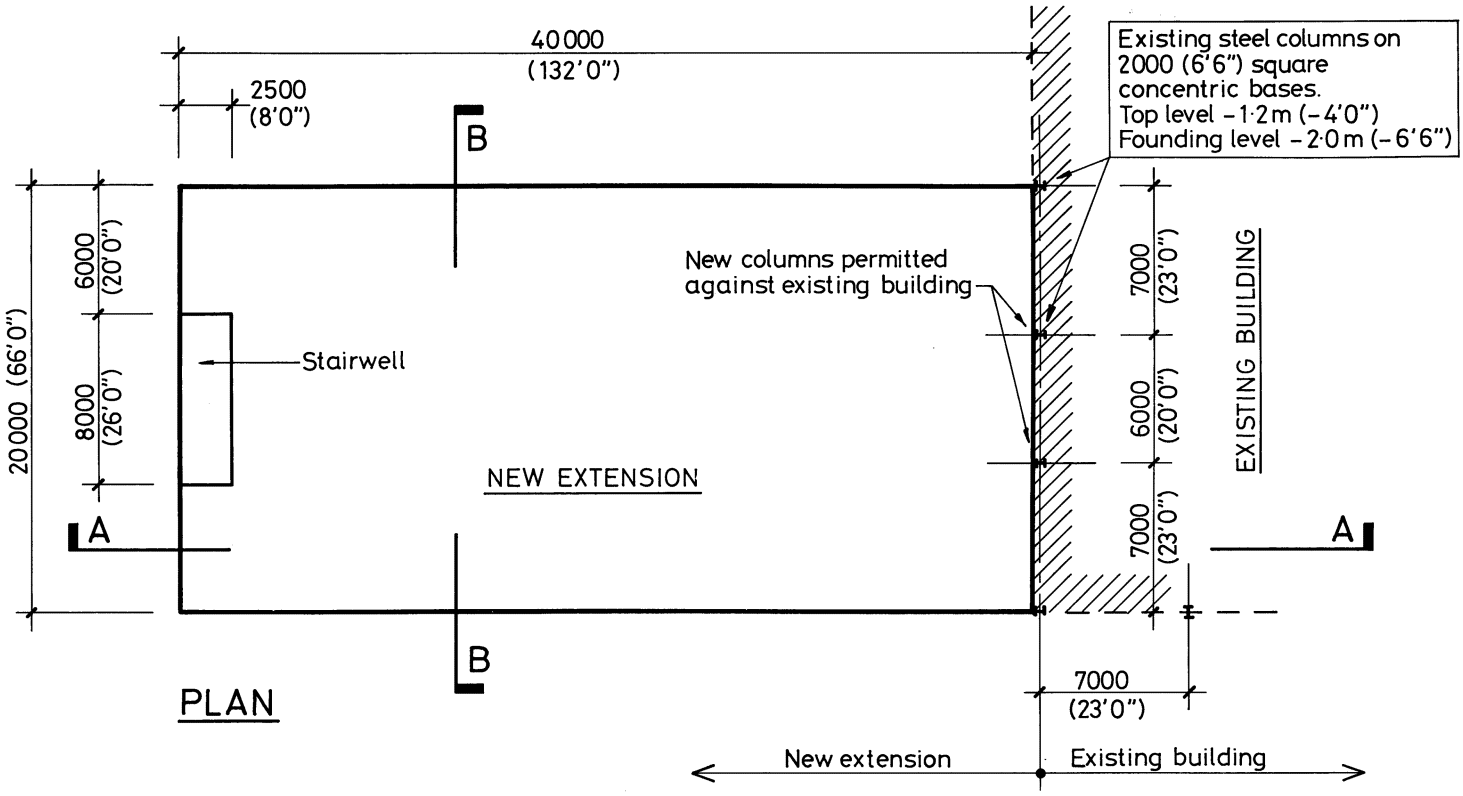
In selecting and developing your design you should also remember the guidance given in the Institution's report, 'Aims of Structural Design', and in particular:

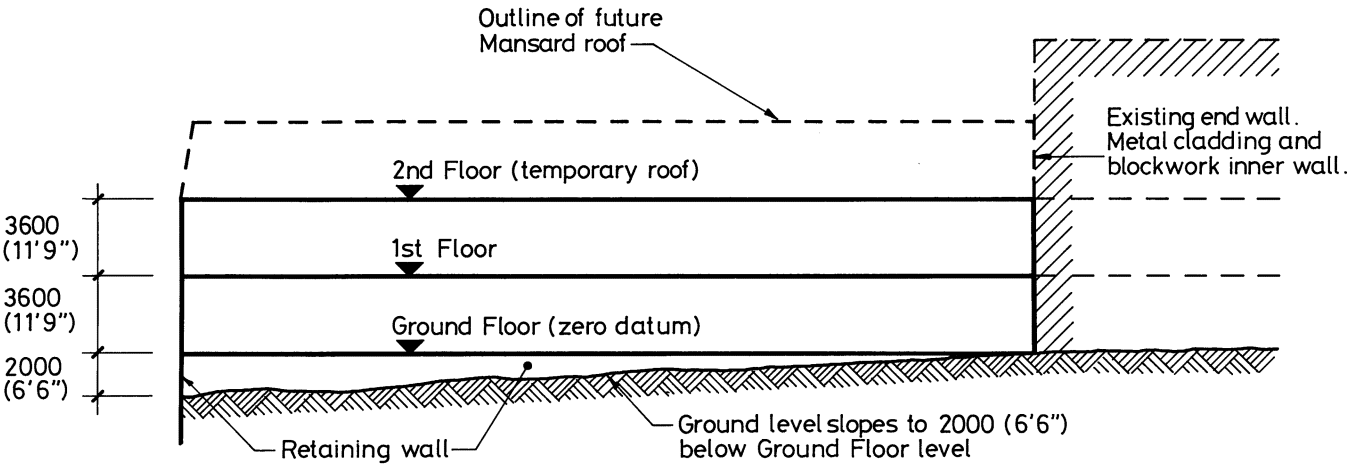
(1) 'the structure must be safe',

(2) 'a good design has certain typical features – simplicity, unity and necessity',

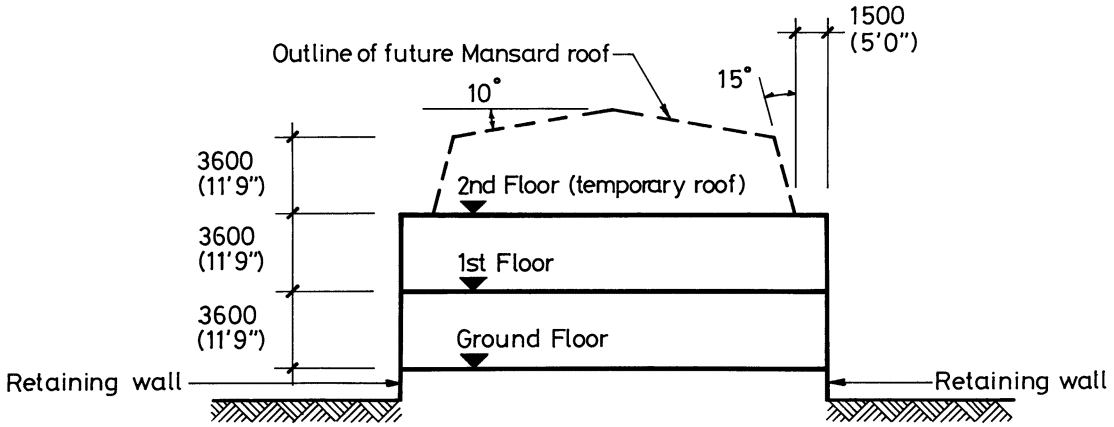
(3) 'the structure must fulfil its intended function'.

If you have difficulty in deciding the correct interpretation of a question, pay particular attention to point 5, 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.





SECTION A-A



SECTION B-B

NOTE All levels are in metres (feet and inches)
Other dimensions are in millimetres (feet and inches)

FIGURE Q1

Question 1
Laboratory Extension

Client's requirements

1. A two storey building for use as an extension to an existing laboratory and research centre; see Figure Q1.
2. The headroom required to the ceiling is 2.6m (8′-6″) and there shall be a clear services void below the structure of 0.4m (1′-4″).
   The floor to floor height is 3.6m (11′-9″) to match existing.
3. Columns are to be as small as possible and to have a minimum spacing of 6m (20′-0″).
4. Side cladding is to be lightweight with a 1.5m (5′-0″) high strip of glazing on all external elevations.
5. The extension is to be structurally independent of the existing building. Cross bracing is not admissible in any of the external elevations. The staircase is lightweight construction and may not be taken into account in assessing stability.
6. Provision is to be made for an upward mansard extension on the temporary roof at the eventual second floor level. The temporary roof is to receive a weathering surface with a design life of 5 years.
7. The new extension will be accessed principally from the existing building via new floor to ceiling openings at ground and first floors. The openings are to be made as late as possible during construction of the extension.
8. Operation of the existing building shall be continuous throughout the construction.

Imposed loadings:

9. Floors and temporary roof — 5.0kN/m^2 (100lbf/ft^2)
   Ceilings and services — 1.0kN/m^2 (20lbf/ft^2)

Site conditions:

10. The building is situated on the outskirts of a small country town. Basic wind speed is 42 m/s (94 miles/hr)

Ground conditions:

11. Ground level to 0.6m (2′-0″) — Top soil and loose fill
    0.6m (2′-0″) to 1.0m (3′-0″) — Gravel N = 10
    1.0m (3′-0″) and below — Clay C = 75kN/m^2 (1500lbf/ft^2)
    Groundwater is not present

Omit from consideration

12. Detail design of stairs, side cladding and upwards extension.

Part 1 (40 marks)

a. Prepare an illustrated design appraisal indicating two distinct and viable structural solutions for the building and its foundation and floors. Identify clearly the functional framing, the load transfer and stability aspects of each scheme. Identify the solution you recommend giving reasons for your choice.

b. During excavation of the foundations, a disused and leaking oil tank 3m (10′-0″) x 3m (10′-0″) x 3m (10′-0″) deep and 1m (3′-0″) below the surface is discovered. Oil contamination has spread over an area approximately 10m (30′-0″) x 10m (30′-0″) beneath the new building. Write a letter to the client advising of the implication of this leakage and how you would recommend dealing with the problem.

Part 2 (60 marks)

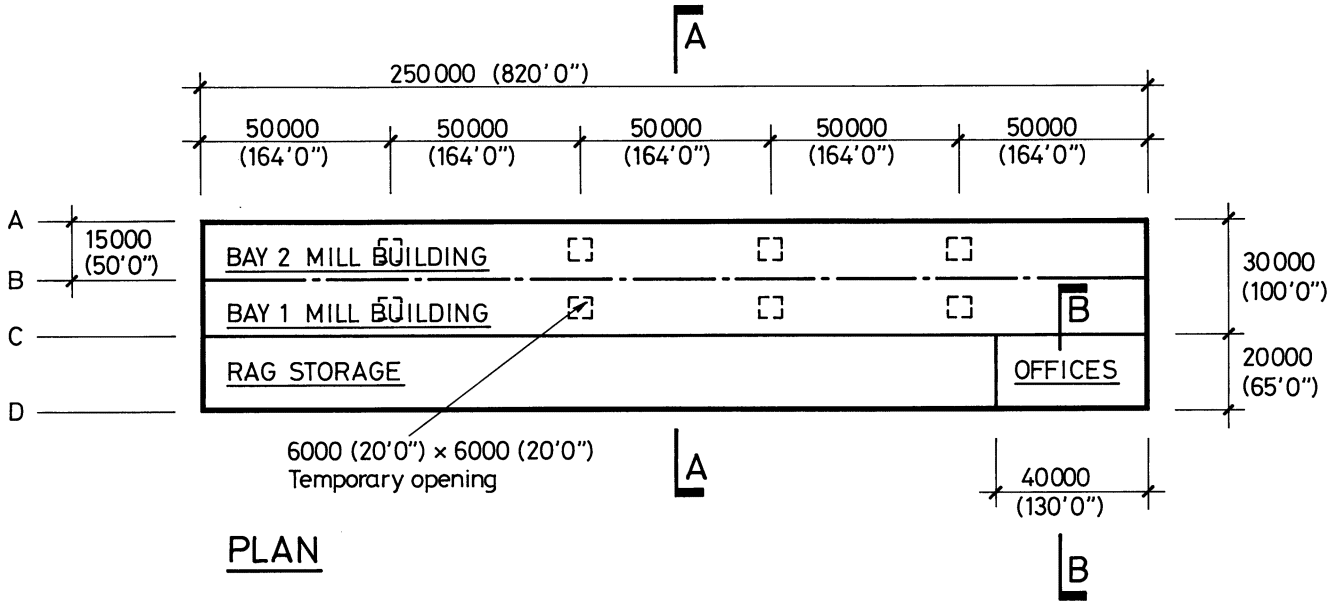
For the solution recommended in Part 1(a):

c. Prepare sufficient design calculations to establish the form and size of all principal structural elements including the ground slab and foundations, retaining wall, ground floor slab and temporary covering.

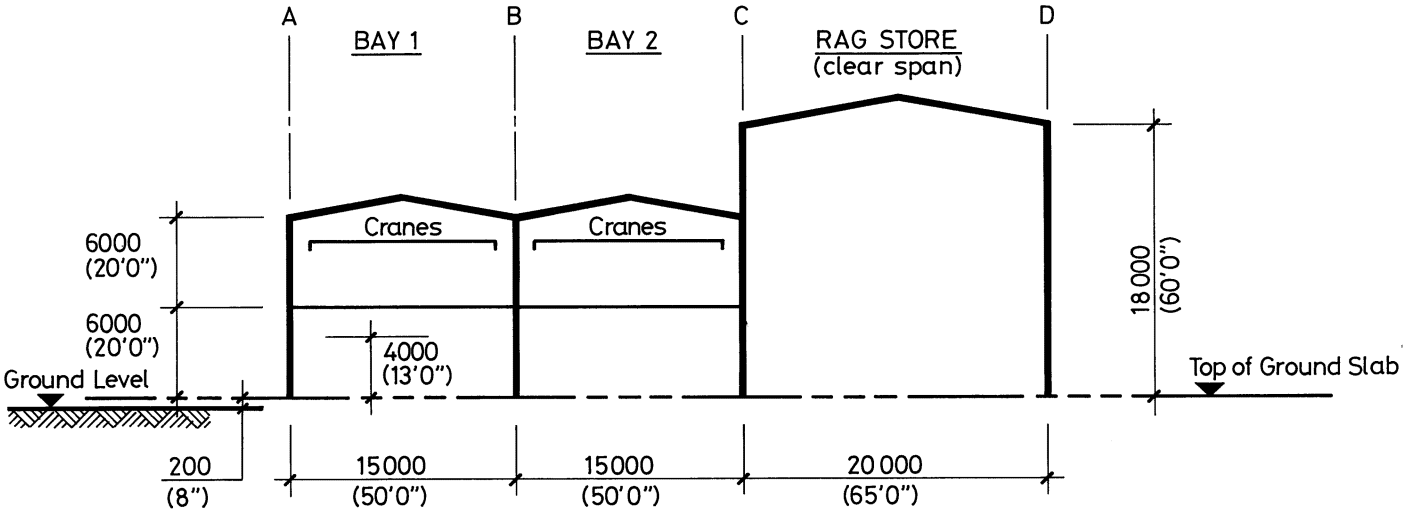
d. Prepare general arrangement plans, sections and elevations necessary to show the dimensions, layout and disposition of the structural elements as required for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of:
   (i) The provision for the future mansard leg connection to the temporary roof.
   (ii) The junction of the retaining wall and an external column.
   (iii) A section through the temporary roof showing the edge detail and provision for drainage.

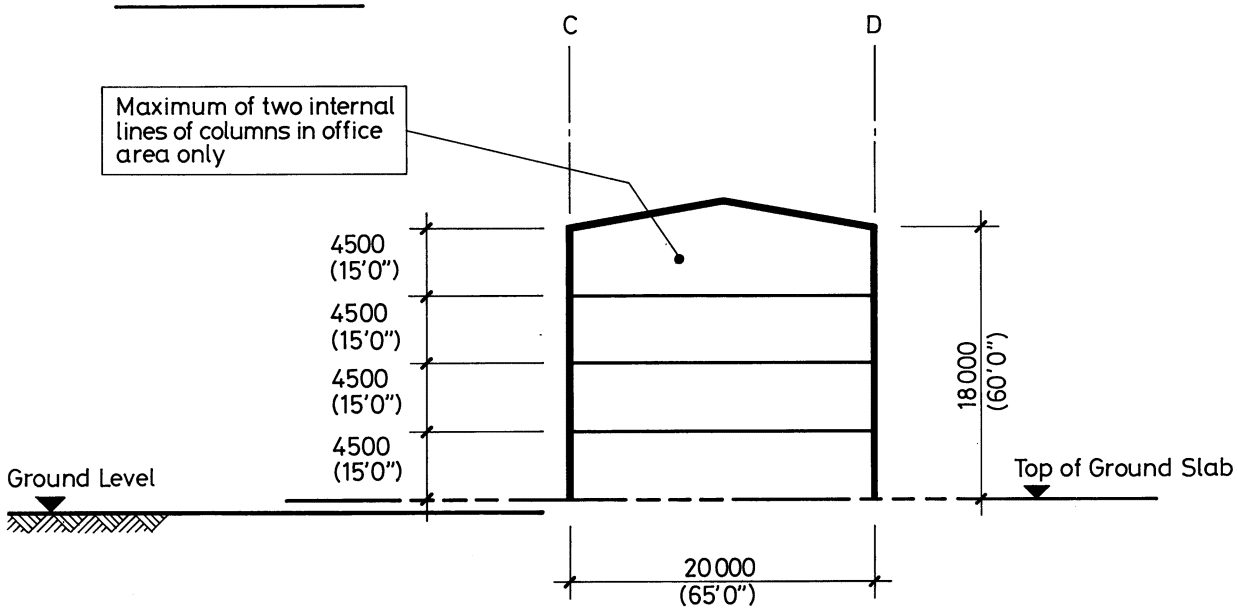
f. Prepare an outline statement indicating how the interior of the existing building is screened from the extension during construction and how the new openings are made in the side of the existing building.



PLAN



SECTION A-A



SECTION B-B

NOTE All dimensions are in millimetres (feet and inches)

FIGURE Q2

Question 2
Paper Mill Building

Client's requirements

1. A two storey two bay papermill building 250m (820′-0″) long and 30m (100′-0″) wide, plus an adjacent four storey high bay rag storage building and office. See Figure Q2.
2. The floor to floor height in the mill area is 6.0m (20′-0″) with a clear headroom of 4.0m (13′-0″) for the ground storey.
3. Two 10 tonnes (10 tonf) electric overhead travelling (EOT) cranes, with the crane rails 5m (16′-0″) above the first floor level, are required to operate in tandem in each bay over the whole length of the mill area.
4. In the mill area there is one line of internal columns on gridline B, and two lines of internal columns are permitted in the office area. However, no internal columns are permitted in the high bay rag store.
5. The first floor of the mill building is to have an additional 100 mm (4″) of insitu concrete added to the floor to allow machine bases to be recessed into it.
6. Four temporary openings 6m (20′-0″) by 6m (20′-0″) are required along the centre line of each bay of the mill area to allow machinery to be hoisted into position using the EOT cranes.
7. External cladding (including roofs) to be profiled metal sheeting. All elevations are also to have a 140mm (6″) dense concrete block inner wall 2m (6′-6″) high at each floor.

Imposed loadings:

8. Office roof:

Ceiling/services	0.5kN/m^2 (10lbf/ft^2)
Superimposed	0.6kN/m^2 (12.5lbf/ft^2)
Other roofs:	
Services	2.0kN/m^2 (40lbf/ft^2)
Superimposed	0.6kN/m^2 (12.5lbf/ft^2)
Floors:	
Office	2.5kN/m^2 (50lbf/ft^2)
Other	12.0kN/m^2 (250lbf/ft^2)
Each crane:	
Crane weight	2 tonnes (2 tonf)
Crab weight	0.5 tonnes (0.5 tonf)
Lift	10 tonnes (10 tonf)
Wheel centres	2.0m (6′-6″)
Minimum clear distance between cranes	2.0m (6′-6″)
Minimum hook approach	1.0m (3′-0″)

Site conditions

9. The building is situated on the outskirts of a large city. Basic wind speed 44m/s (98 mile/h).
10. Ground conditions:

Ground level to 1.6m (5′-0″)	Loose fill
1.6m (5′-0″) and below	Boulder clay, safe ground bearing pressure 200kN/m^2 (2 tonf/ft^2)

Ground water is not present.

Omit from consideration

11. Detailed design of any stairs/lifts, cladding, storage racking or cranes.

Part 1 (40 marks)

(a) Prepare an illustrated design appraisal indicating two distinct and viable structural solutions for the building. Identify clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend giving reasons for your choice.

(b) After fabrication, but before erection, the client decides to omit the roof valley along gridline B, so that the ridge line for the two bays is on gridline B. Write a letter to the client explaining how this can be achieved.

Part 2

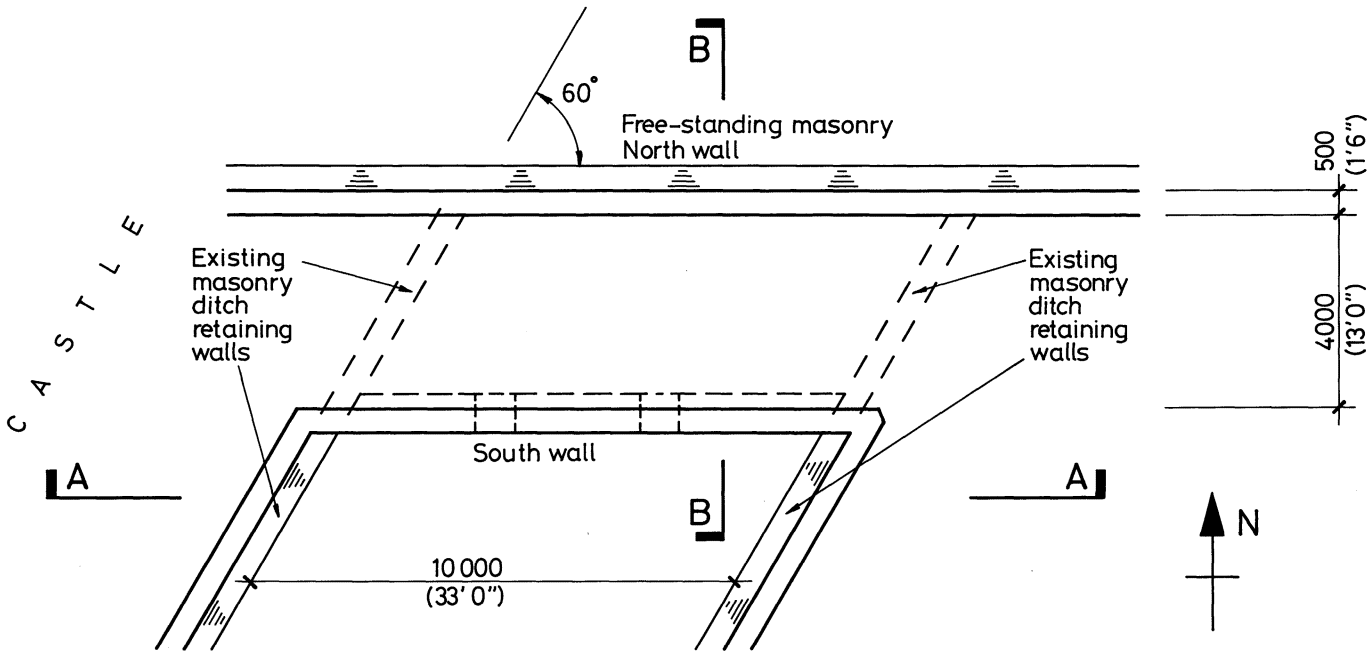
For the solution recommended in 1 (a) (60 marks)

(c) Prepare sufficient design calculations to establish the form and size of all principal structural elements including foundations, floor slabs and crane rails.

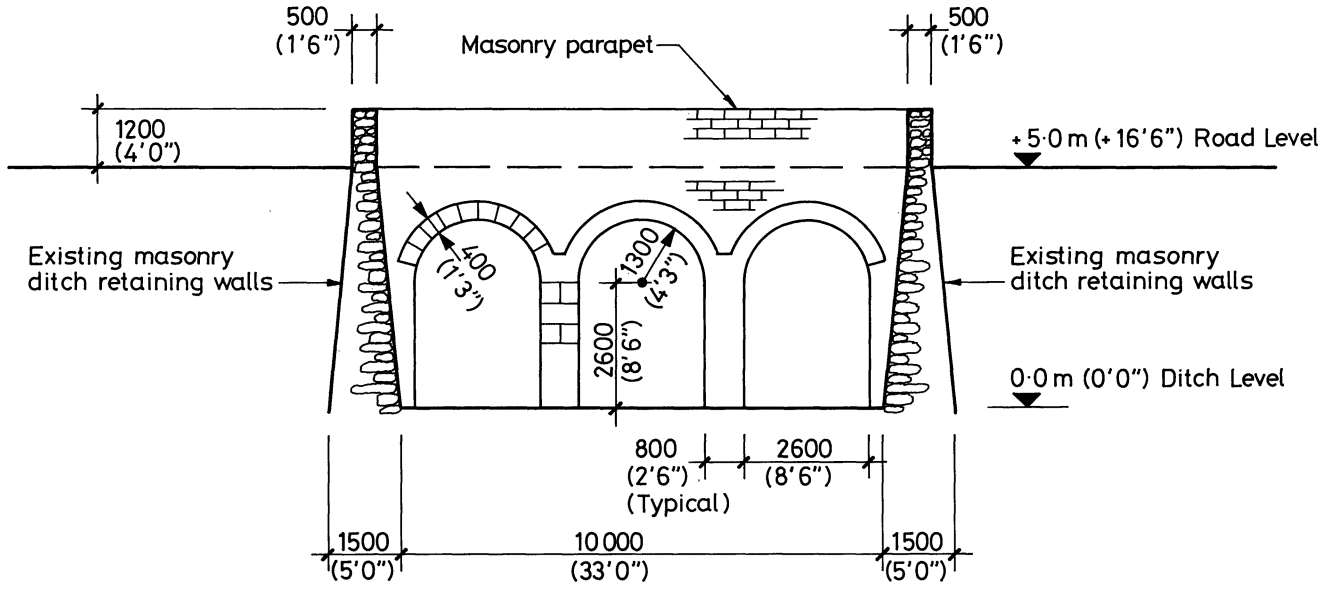
(d) Prepare general arrangement plans, sections and elevations necessary to show the dimensions, layout and disposition of the structural elements as required for estimating purposes.

(e) Prepare clearly annotated sketches to illustrate details of:
   (i) The connection of a column on gridline B to the crane rails.
   (ii) The junction between the first floor and an internal column on gridline B.
   (iii) How the roof valley will be replaced as required in Part 1 (b).

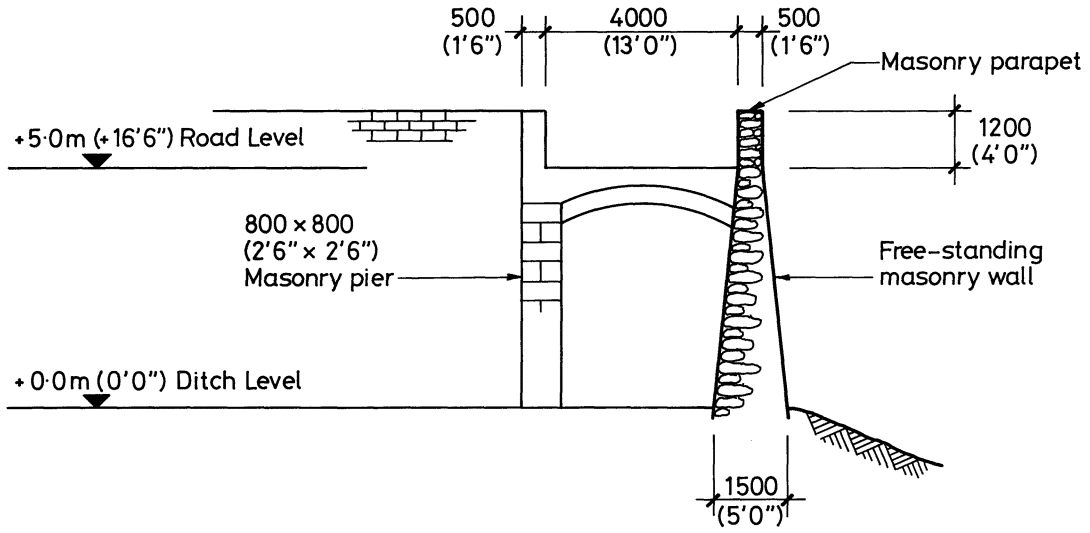
(f) Describe briefly the methods of corrosion protection appropriate for the warm damp environment in the mill building.



PLAN ON EXISTING BRIDGE



SECTION A-A



SECTION B-B

NOTE All levels are in metres (feet and inches)
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FIGURE Q3

Question 3

Castle Access Bridge

An existing single lane masonry bridge crosses a ditch at the entrance to a castle as illustrated in Figure Q3.

The bridge is suffering from structural distress due to settlement and requires to be strengthened to cope with modern design loadings and widened to provide two lanes. The client has decided that the existing bridge requires reconstruction. The castle is a building of historic importance and the new bridge must be designed to match the existing. A bridge of particularly high durability and low maintenance is required.

Client's requirements

1. The new bridge is required to have an external appearance identical to that of the existing bridge when viewed from the south, although the new structure need not be of the same structural form and profile as the existing structure. Elements of the new bridge must not be visible from road level.
2. The existing south wall is to be carefully taken down and reconstructed in a location to suit the width of the new bridge.
3. The new bridge is to have a clear width between kerbs of 6.0m (20′-0″) with a 1.8m (6′-0″) wide footpath on one side and a 0.6m (2′-0″) strip on the other. The north parapet is to be retained in its present location with the new bridge immediately adjacent.
4. The existing masonry walls and the relocated south wall are not to be used to support any vertical or horizontal loads from the new bridge.
5. The castle has no other entrance and single lane vehicle access must be provided at all times during construction.

Imposed loading

6. Imposed vertical loading on the bridge shall comprise a uniformly distributed load of 15kN/m^2 (300lbf/ft^2) with an alternative loading for local deck elements of 100kN (10 tonf) on a 0.3m (1′-0″) x 0.3m (1′-0″) square contact area.
7. A horizontal load of 250kN (25 tonf) in any direction applied at deck level.

Site conditions

8. The ground conditions vary significantly across the bridge span as noted below.

West abutment	0-0.4m (1′-4″)	Existing road make up
	0.4m (1′-4″)-3.5m (11′-5″)	Loose fill N = 10
	Below 3.5m (11′-5″)	Igneous rock
East abutment	0-0.4m (1′-4″)	Existing road make up
	0.4m (1′-4″)-9.0m (29′-6″)	Loose fill N = 10
	Below 9.0m (29′-6″)	Igneous rock

   Ditch: Ground conditions should be interpolated between abutments.
   No ground water was encountered.
9. Temperature range 45C° (80F°)

Omit from consideration

10. Design and assessment of masonry walls and parapets.

Part 1 (40 marks)

a. Prepare an illustrated design appraisal indicating two distinct and viable structural solutions for the bridge construction. Identify clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice.

b. After your recommended solution has been approved in principle, the Client asks if it is possible to incorporate 6 service pipes/ducts up to 500mm (1′-8″) in diameter within the deck structure. Write a letter to the Client explaining the implications for the design and how the services would be accommodated in both the deck and the sub-structure.

Part 2 (60 marks)

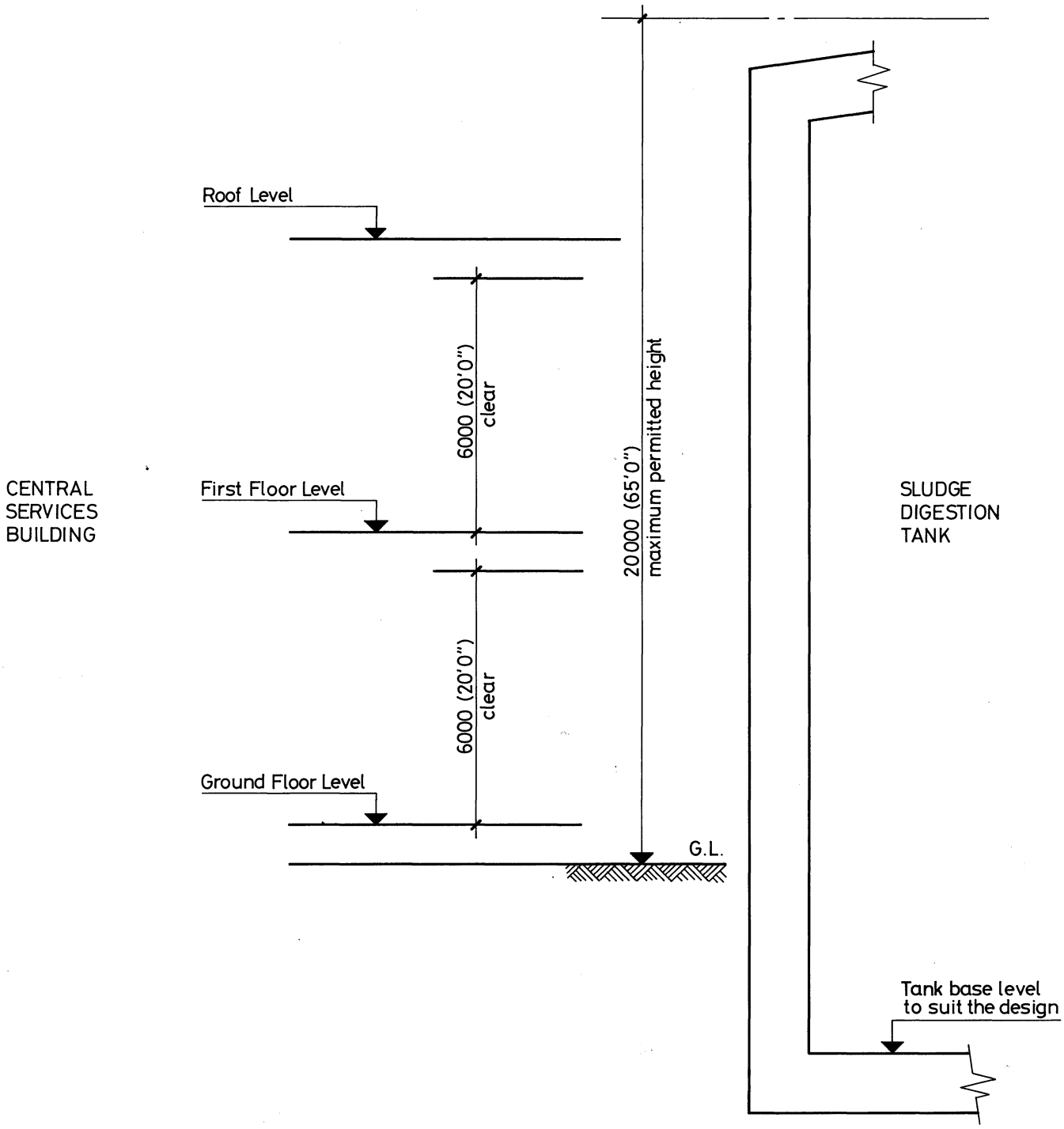
For the solution recommended in Part 1(a):

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

d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of:
   (i) The joint between the bridge deck and the south wall.
   (ii) An end support, including any bearings.
   (iii) The south wall pier foundations.

f. Prepare a brief method statement for the safe construction of the site works including the necessary phasing to ensure that the road is open at all times.



PART SECTION THROUGH ONE TANK AND CENTRAL SERVICES BUILDING

NOTE All dimensions are in millimetres (feet and inches)

FIGURE Q4

Question 4
Sludge Digestion Tanks

Client's requirements

1. Six covered sludge digestion tanks served from a conveniently situated enclosed and suitably clad central services building whose two storeys will contain all the distribution pipework and plant (Figure Q4).
2. Each tank should have a capacity of 5,000 cu m (180,000 cu ft) with an additional 10% space over the sludge for gas collection.
3. The two floors carrying the pipework and plant within the central services building should each have an area of 1200 sq m (13,000 sq ft). Although internal columns are acceptable within the central services building their spacing is not to be less than 10.0m (33′-0″). Minimum headroom in the central services building is to be 6.0m (20′-0″).
4. The roofs to the tanks and central services building are to be waterproofed externally and fall to the perimeter for drainage purposes. A draw-off chamber 2m x 2m (6′-0″ x 6′-0″) is to be provided at the bottom of each tank.

Imposed loading

5. Central Services Building:	Floors	5.0kN/m^2	(100lbf/ft^2)
	Roof	0.75kN/m^2	(15lbf/ft^2)
Digestion Tanks:	Roof	0.75kN/m^2	(15lbf/ft^2)

Site conditions

6. A level site with adequate access from all sides.
7. Maximum height of the tanks above ground level permitted by planning consent is 20m (65′-0″).
8. Ground conditions:
   0-0.5m (1′-6″) made ground
   0.5m (1′-6″)-2.0m (6′-6″) soft clay average C = 25kN/m^2 (500 lbf/ft^2).
   2.0m (6′-6″) - 5.0m (16′-6″) firm clay average C = 50 kN/m^2 (1000 lbf/ft^2).
   5.0m (16′-6″) and below stiff clay average C = 200 kN/m^2 (4000 lbf/ft^2).
   No ground water is present.
9. Sludge - Specific gravity 1.02.
   Sludge - Viscosity as water.
   Gas pressure over sludge 2.0 kN/m^2 (40 lbf/ft^2).

Omit from consideration

10. Detail design of stairs and access within the central services building, although the scheme must accommodate these aspects.
11. Access ladders, plant and pipework.
12. Hydraulic requirements.

Part 1 (40 marks)

a. Prepare an illustrated design appraisal indicating two distinct and viable structural solutions for the proposed tanks and associated central services building. Identify clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice.

b. After your recommended solution has been approved in principle the Client considers reducing the number of tanks to four, whilst maintaining the overall storage capacity of 30,000 cu m (1.08M cu ft).
   Write a letter to the Client outlining the possible structural advantages or disadvantages this proposed change may have on the design of the scheme together with any construction and financial implications.

Part 2 (60 marks)

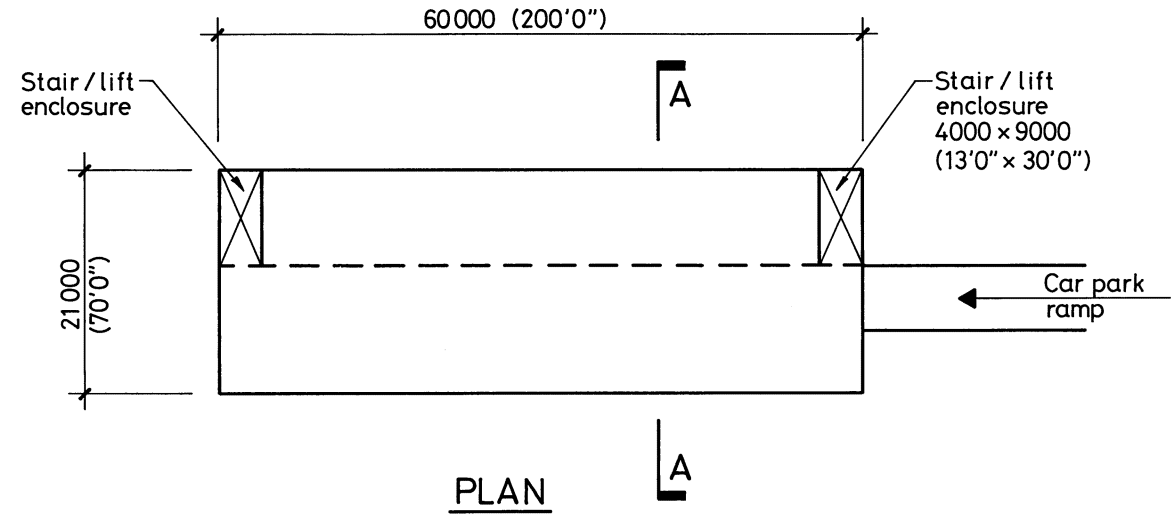
For the solution recommended in Part 1(a):

c. Prepare sufficient design calculations to establish the form and size of all principal structural elements for both the central services building and the tanks including foundations.

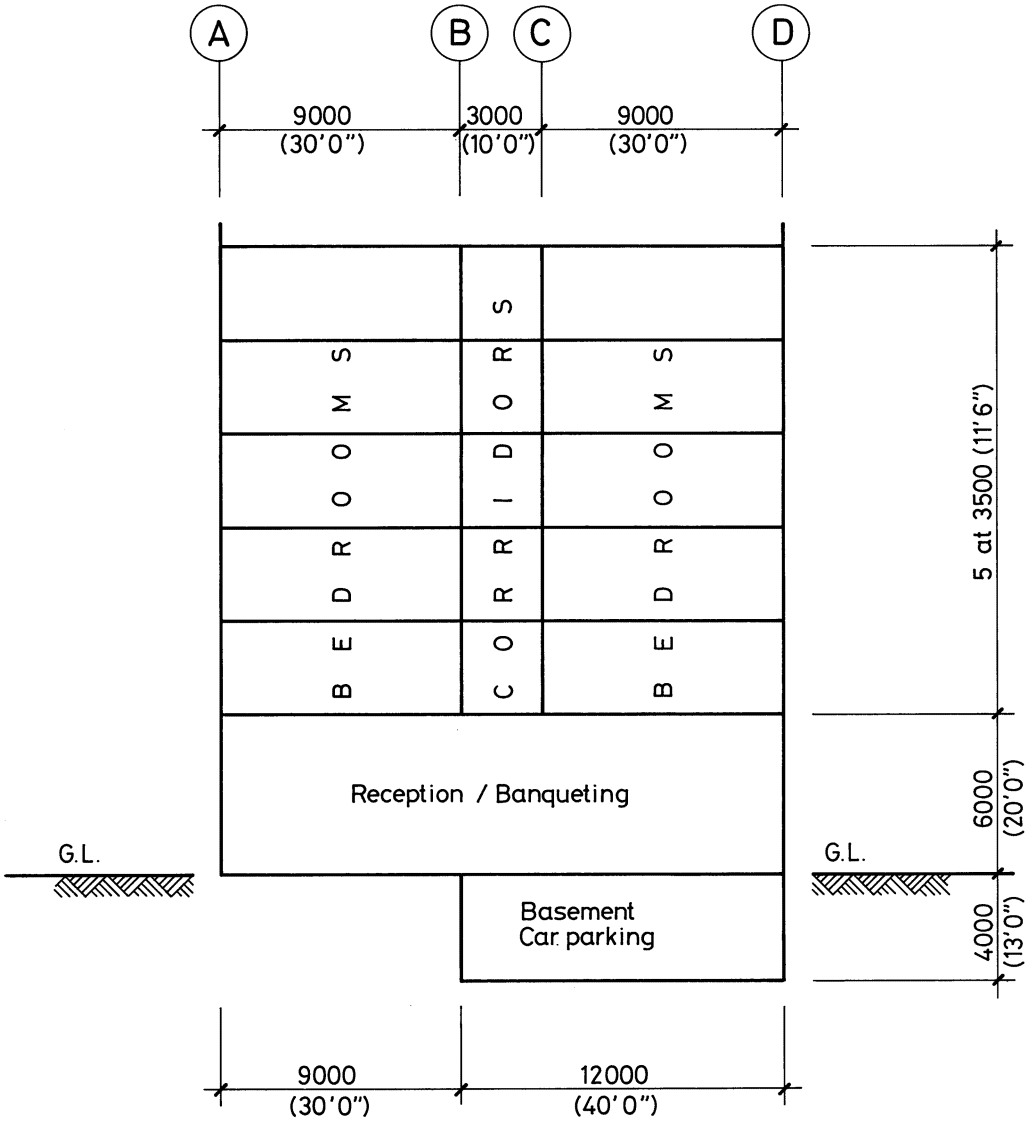
d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements as required for estimating purposes.

e. Prepare clearly annotated sketches to illustrate details of:
   (i) The junction between a tank wall and its base.
   (ii) A beam and its support at first floor level in the central services building.
   (iii) The junction between a tank wall and the roof of the central services building.

f. Discuss what measures need to be taken to ensure that the tanks are both watertight and gas-tight. Include sketches as necessary to amplify your recommendations.



PLAN



SECTION A-A

NOTE All dimensions are in millimetres (feet and inches)

FIGURE Q5

Question 5
Hotel with integral car parking

Client's requirements

1. A six storey hotel 60m (200′-0″) by 21m (70′-0″) with integral parking for approximately 25 cars at basement level.
2. The ground floor is to provide reception and banqueting facilities and therefore the minimum spacing of internal columns is to be 8m (26′-0″).
3. The upper floors are to contain 140 rooms on 5 floors together with access corridors and stair/lift enclosures at each end of the building.
4. Minimum clear headroom is to be 2.4m (8′-0″) in the bedroom floors, 4.5m (15′-0″) in the reception/banqueting areas and 3.0m (10′-0″) in the basement area.
5. Fire resistance of two hours is to be provided.
6. External elevations are to be extensively glazed at ground floor level, and are to be of cavity wall construction to the upper floors.

Imposed loading

7. Bedroom floors 2.0 kN/m^2 (40 lbf/ft^2).
   Reception/banqueting 5.0 kN/m^2 (100 lbf/ft^2).
   Basement car park 2.5 kN/m^2 (50 lbf/ft^2).

Site conditions

8. A level city centre site. Basic wind speed 40 m/s (90m/h).
9. Ground conditions:
   0-0.5m (1′-6″) made ground.
   0.5m (1′-6″) - 3.0m (10′-0″) loose sand and gravel N = 6.
   3.0m (10′-0″) and below stiff clay C = 200 kN/m^2 (4000 lbf/ft^2).
   Ground water is at 2.0m (6′-6″) below ground level.

Omit from consideration

10. Design of car park ramp.
11. Detail design of staircase and lift shafts, although their contribution (if any) to overall stability and load transfer must be stated in Part 1(a).

Part 1 (40 marks)

a. Prepare an illustrated design appraisal indicating two distinct and viable structural solutions for the proposed structure. Identify clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend, giving reasons for your choice.

b. After your recommended solution has been approved in principle the Client considers increasing the number of basement car spaces to approximately 50. Write a letter to the Client outlining a solution for this revised brief which in your opinion will have the minimum impact on costs and construction programme for the scheme. A sketch may be appended to the letter to illustrate your solution.

Part 2 (60 marks)

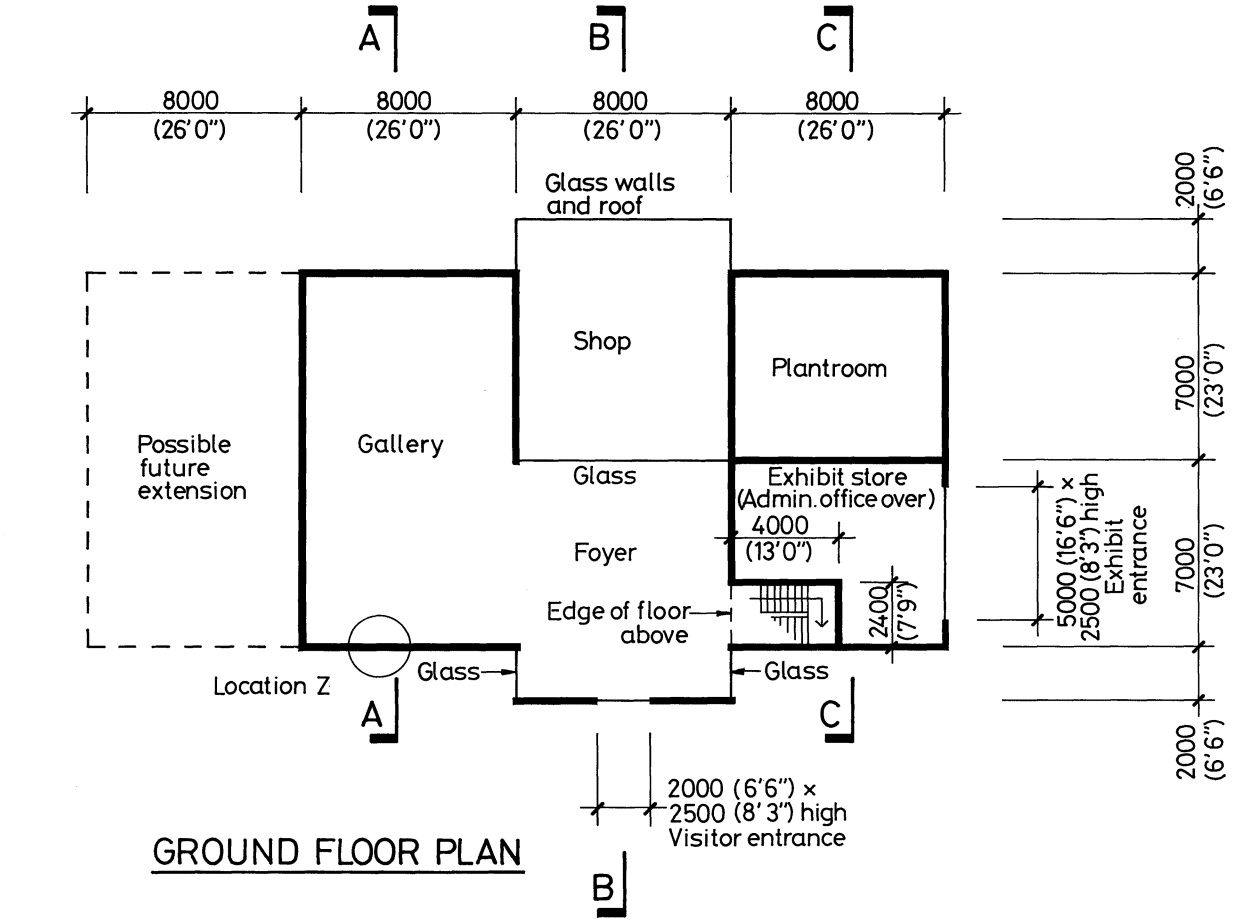
For the solution recommended in Part 1(a):

c. Prepare sufficient design calculations to establish the form and size of all principal structural elements, including basement and foundations.

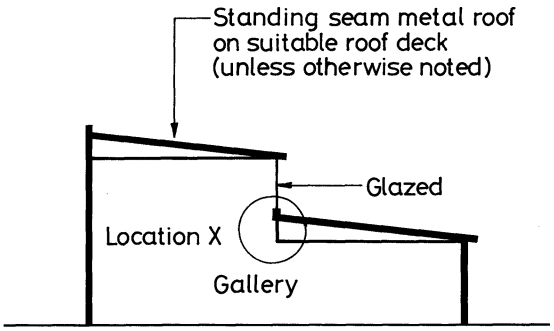
d. Prepare general arrangement plans, sections and elevations to show the dimensions, layout and disposition of the structural elements required for estimating purposes including the layout of car spaces at basement level.

e. Prepare clearly annotated sketches to illustrate details of:
   (i) The junction of the basement floor and a wall.
   (ii) A beam and column connection at an upper floor level showing the means of supporting the external cavity wall.
   (iii) A typical foundation on grid line A.

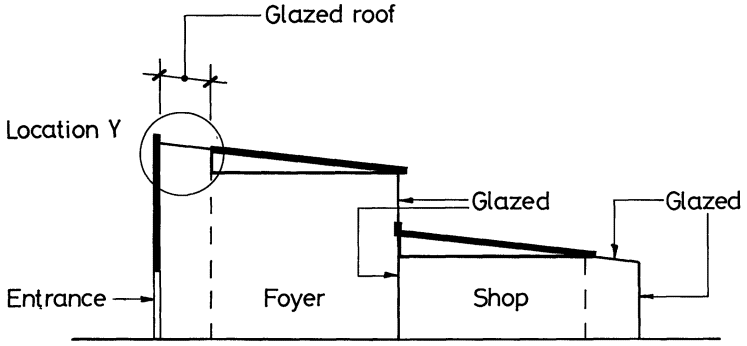
f. Prepare an illustrated sequence for the safe construction of the structure including any temporary works considered necessary.



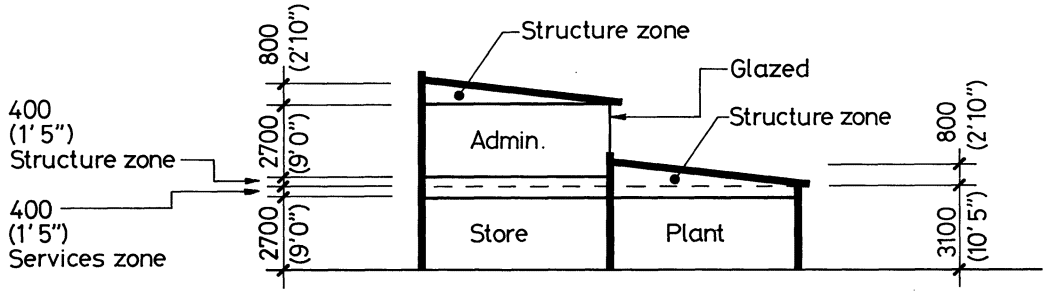
GROUND FLOOR PLAN



A – A



B – B



C – C

NOTE All dimensions are in millimetres (feet and inches)

FIGURE Q6

Question 6
Painting & Sculpture Gallery

Client's requirements

1. A new building for a small gallery to exhibit paintings and sculpture. See Figure Q6.
2. Column-free rooms are required throughout.
3. Except where glazed, internal surfaces of walls to the gallery, foyer and shop areas are to be free from projections because the walls have to support large paintings and works of art.
4. To meet security requirements the external walls must be of robust construction.
5. Structural members exposed to view must be neatly detailed.
6. Appropriate structural members must have a fire resistance of 1 hour.

Site Conditions

7. The site is located in a park, in a suburban residential district on the edge of a large town. Basic wind speed 45 m/s (100 mile/h).
8. Ground conditions:
   0.0m (0′-0″) to 0.3m (1′-0″)Topsoil
   0.3m (1′-0″) to 1.5m (5′-0″)Sand N = 5
   1.5m (5′-0″) and below Gravel N = 25

   No ground water was encountered.

Omit from consideration

9. Stairs.

Part 1 (40 marks)

a. Prepare an illustrated design appraisal indicating two distinct and viable structural solutions for the building. Identify clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend giving reasons for your choice.

b. After the scheme has been agreed, the client asks for advice on the implications of extending the gallery floor space at some future date into the area shown. Prepare a letter to the architect discussing how the scheme already agreed for the building structure could be modified to allow this to happen with minimum disruption while the gallery is in use.

Part 2 (60 marks)

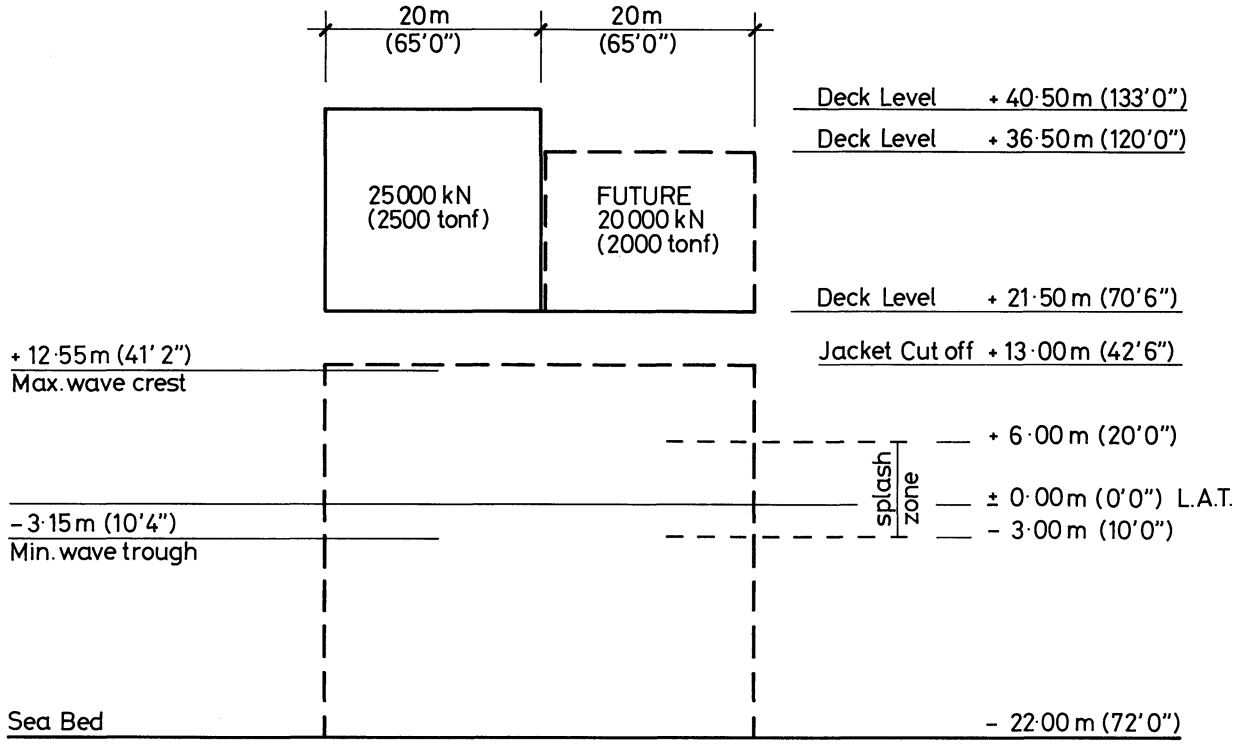
For the solution recommended in Part 1(a):

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

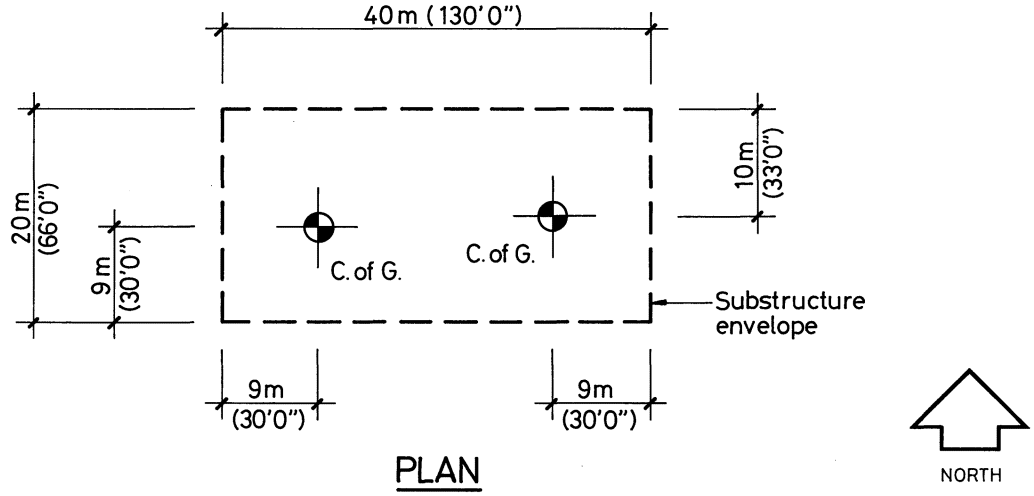
d. Prepare general arrangement plans, sections and elevations necessary to show the dimensions, layout and materials of the structural elements as required for estimating purposes.

e. Prepare clearly annotated sketches to show details of the structure at the following locations:
   (i) Vertical structure to horizontal structure at Location X.
   (ii) Roof structure to wallhead at Location Y.
   (iii) Lateral supporting structure to external wall in the vicinity of Location Z.

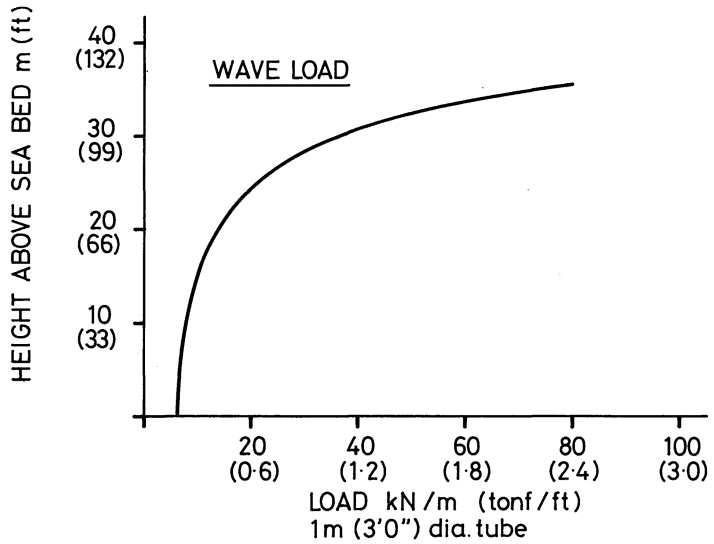
f. Prepare an outline method statement for the construction of the building, including the provision of any temporary support or bracing required.



ELEVATION



PLAN



NOTE All dimensions and levels are in metres (feet and inches)

FIGURE Q7

Question 7

Jacket for Fixed Production Platform.

Client's requirements

1. The envelope for a jacket for a fixed production platform on a new gas field in the southern North Sea is indicated in Figure Q7.
2. The jacket is to support an all inclusive topsides load of 45000 kN (4500 tonf) in the form of two modules. One module of 25000 kN (2500 tonf) is to be placed on the west side of the jacket during the same installation period as that for the jacket. The second module is to be installed at a later date on the east side of the jacket. This module has a weight of 20000 kN (2000 tonf). The centre of gravity of each module is shown on figure Q7.
3. The jacket profile must not extend beyond the substucture envelope indicated. The boundaries of the envelope may be considered to be grid centre lines.
4. The field life is to be 30 years.
5. The jacket is to be installed in a single lift and is to have a maximum lift weight of 2100 tonnes (2100 tonf). Due to the presence of existing structures the installation can only be installed with the semi-submersible crane vessel (SSCV) in the south.

Site conditions

6. Basic wind speed 43.5 m/sec (100 mile/h).
7. Wave Data

Design Wave height	15.70m (51′-6″)
Wave period	12.80 secs.
Wave length	198.60m (651′-6″).
Wave load for 1m (3′-0″) diameter tube: see Figure Q7.	
Drag coefficient	0.70
Inertia coefficient	2.00

   Marine growth thickness can be assumed to vary linearly between 150 mm (6″) at the lowest astronomical tide (L.A.T.) to 50 mm (2″) at the sea bed.

   The jacket can be considered to be drag dominated.
8. Splash Zone is from 3.0m (10′-0″) below L.A.T. to 6.0m (20′-0″) above L.A.T.
9. Ground conditions:
   Dense fine sand $\emptyset = 35°$, $\delta = 30°$, $Nq = 40$.

Omit from consideration:

10. Design of topsides.
11. Detail design of risers etc.
12. Effects of tide and surge.
13. Dynamic and fatigue effects.
14. Installation aids other than pad eyes/pad ears.
15. Mud mats.

Part 1 (40 marks)

a. Prepare an illustrated design appraisal indicating two distinct and viable solutions for the proposed jacket structure and foundations including the method of load out and installation. Indicate clearly the functional framing, load transfer and stability aspects of each scheme. Identify the solution you recommend giving reasons for your choice.

b. Having received your recommended design your client then proposes to pre-drill 6 wells at one end of the structure.

   Write to your client explaining the structural implications this might have on your chosen solution.

Part 2 (60 marks)

c. Prepare sufficient design calculations to establish the form and size of all significant structural elements to ensure both stability and adequate strength under both temporary and permanent conditions.

d. Prepare general arrangement plans, elevations and sections to show the dimensions, layout and disposition of the structural elements, including piles and lifting points, as required for estimating purposes.

e. Prepare neat annotated sketches to illustrate the details of:
   (i) A typical jacket to pile connection.
   (ii) The central joint providing support for the future module.
   (iii) A typical lifting point.
   (iv) A typical conductor guide detail.

f. Briefly discuss any methods you would employ to protect the primary steelwork for its design life.