

Chief Examiner critique – Jan ‘24

Q5 – Community centre building

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Introduction

The Examinations Panel has produced this additional preparation guidance document to show what the Chief Examiner (the person who writes the question) was expecting candidates to consider when answering the question.

The critique does not cover all possible solutions for the question but details the fundamental design challenges and shows examples of how these could have been answered. Candidates are encouraged to consider all potential options as part of their preparation work.

No part of this document should be reproduced by candidates in their answers for future exams.

Question Text

Client's Requirements

1. A two-storey community centre is to be constructed to provide flexible arts & teaching space. See Figure Q5.
2. The building is to be located on a previously developed site, within a large city.
3. A minimum clear internal height of 3m is required to each floor, the finished floor-to-floor height for the building is 4.0m. Consideration of services integration is required.
4. The upper ground floor level is to be open plan (no internal columns), with glazed façades (no bracing permitted). The lower ground floor requires provision for four teaching space classrooms. Columns are permitted within classroom walls with a minimum spacing of 6m.
5. The upper ground floor is to incorporate a slim profile and a projecting canopy with no supporting columns below.
6. Access is to be provided to allow for use of lower ground floor roof structure as external garden terrace.
7. The site is bounded by a highway to the south and lies within 15m of railway lines to the north.

Imposed Loading

- | | |
|----------------------------|---|
| 8. Upper Ground Floor Roof | 0.6kN/m ² |
| 9. Lower Ground Floor Roof | 5.0kN/m ² plus allowance of 2.0 kN/m ² for green roof system. |
| 10. All internal floors | 10.0kN/m ² |

Site Conditions

11. The site is located within a large city. Basic wind speed is 40m/s based on a 3-second gust; the equivalent mean hourly wind speed is 20m/s.
12. Ground conditions are consistent across the site:

General site conditions

Ground level – 1.0m	Made ground
1.0m – 1.5m	Soft clays, C = 10kN/m ²
1.5m – 8.0m	Stiff clays, C = 50kN/m ²
Below 8.0m	Mudstone, C = 150kN/m ²
No ground water was encountered.	

Omit from Consideration

13. Detail design of lift/elevator and stair cores.

SECTION 1

(50 marks)

- a. Prepare a design appraisal with appropriate sketches indicating two distinct, viable and sustainable solutions for the proposed structure including the foundations. Clearly indicate the functional framing, load transfer, serviceability, and stability aspects of each scheme. Using sustainability as a key criterion, review and critically appraise the schemes, and identify the solution you recommend, giving reasons for your choice. (40 marks)
- b. After the scheme design is complete, the Client asks you to suggest ways in which the brief could be altered to reduce material usage whilst maintaining the predominantly column free internal spaces. Write to your client proposing possible changes. As part of any proposals made, explain the effect this may have on the design. (10 marks)

SECTION 2

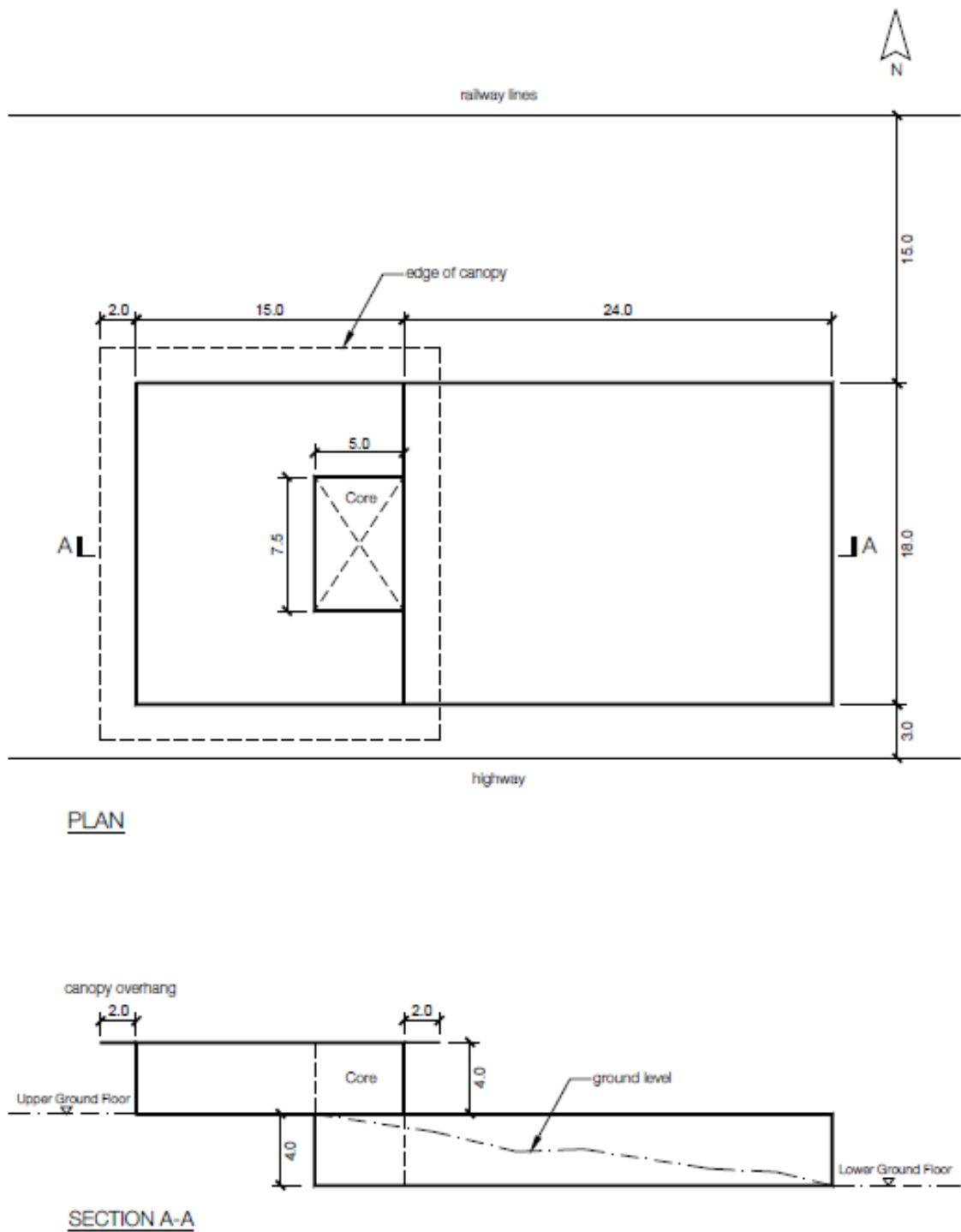
(50 marks)

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 including the foundations. Include approximate A1-A3 carbon calculations for each of your principle elements. (22 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 works. (8 marks)

Question Figure



NOTE: All dimensions are in metres.

FIGURE Q5

Critique

Section 1a – Key challenges

What are the main challenges?

- ▶ The site is defined as being in a city centre location and there are clear development constraints of the highway and railway lines identified by the question. This restricts the use of an open cut technique to form lower ground floor level adjacent to the highway and is expected to generate some discussion regarding working in the vicinity of the railway e.g. large machinery to not over sail, risk of falling and risk of vibration.
- ▶ Limitations on location of internal columns poses restrictions for grid arrangements, however there is some flexibility in the classroom area.
- ▶ There are similarly limitations for the area of glazed building façade and slim profile overhang.
- ▶ The high loaded external roof space is intended to place more emphasis on the supporting beam arrangement rather than for a typical lightly loaded roof.

Framing

Framing solutions are possible with steel, concrete and timber. Possible solutions will likely involve simple framing to the LGF & UGF roof areas, where the back span for the cantilever canopy can readily be addressed in one direction, but will require further trimming where perpendicular to the roof span.

Ground conditions are intended to be compatible with a variety of retaining wall solutions for the full ground facing perimeter of the LGF, but primarily giving options for the retaining wall adjacent to the highway.

Likely options for the structural framing are:

- ▶ Sheet piled retaining wall
- ▶ Contiguous piled retaining wall and concrete faced
- ▶ Secant piled retaining wall with liner wall
- ▶ Reinforced concrete retaining wall with some means of temporary propping e.g. sheet piling or king post system.
- ▶ Foundation solution is assumed to be either slab and pads or raft
- ▶ Superstructure could be steel beams and composite slabs
- ▶ Steel beams and PCC slabs
- ▶ Concrete flat slab
- ▶ Concrete beam and slab
- ▶ There is also potential to split material types, with the lower ground floor acting as a podium and the upper larger span, but more lightly loaded frame being steel or timber.

Stability

The central core can be used for stability, with bracing and/or shear walls to the lower ground floor area. The upper ground floor may incorporate some form of portalised structure or be stabilised back to the main shear core. Consideration of how diaphragm action is realised is important for the lightweight roof in this case.

Foundations

Foundations for this building should be straightforward with competent ground at shallow depth. Over most of the building footprint the LGF will push foundations into the stiff clays, but foundation depth should be watched at either side of the building for bearing into consistent material. Would expect the foundations to be typically strip/pad or raft foundations offered with the scheme design solutions.

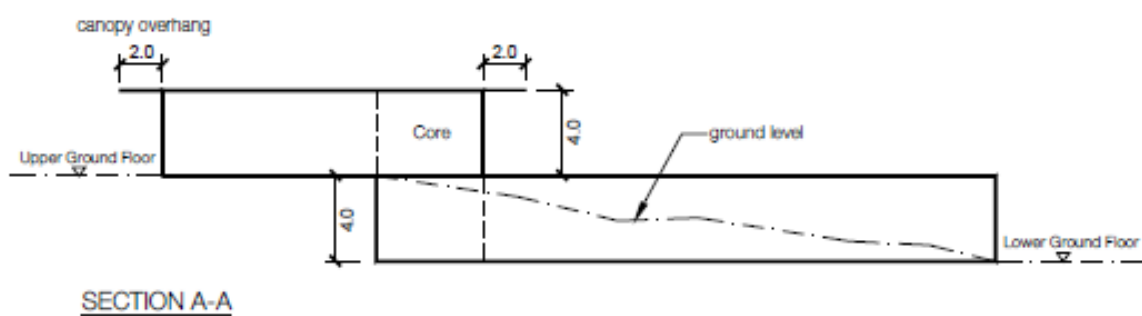
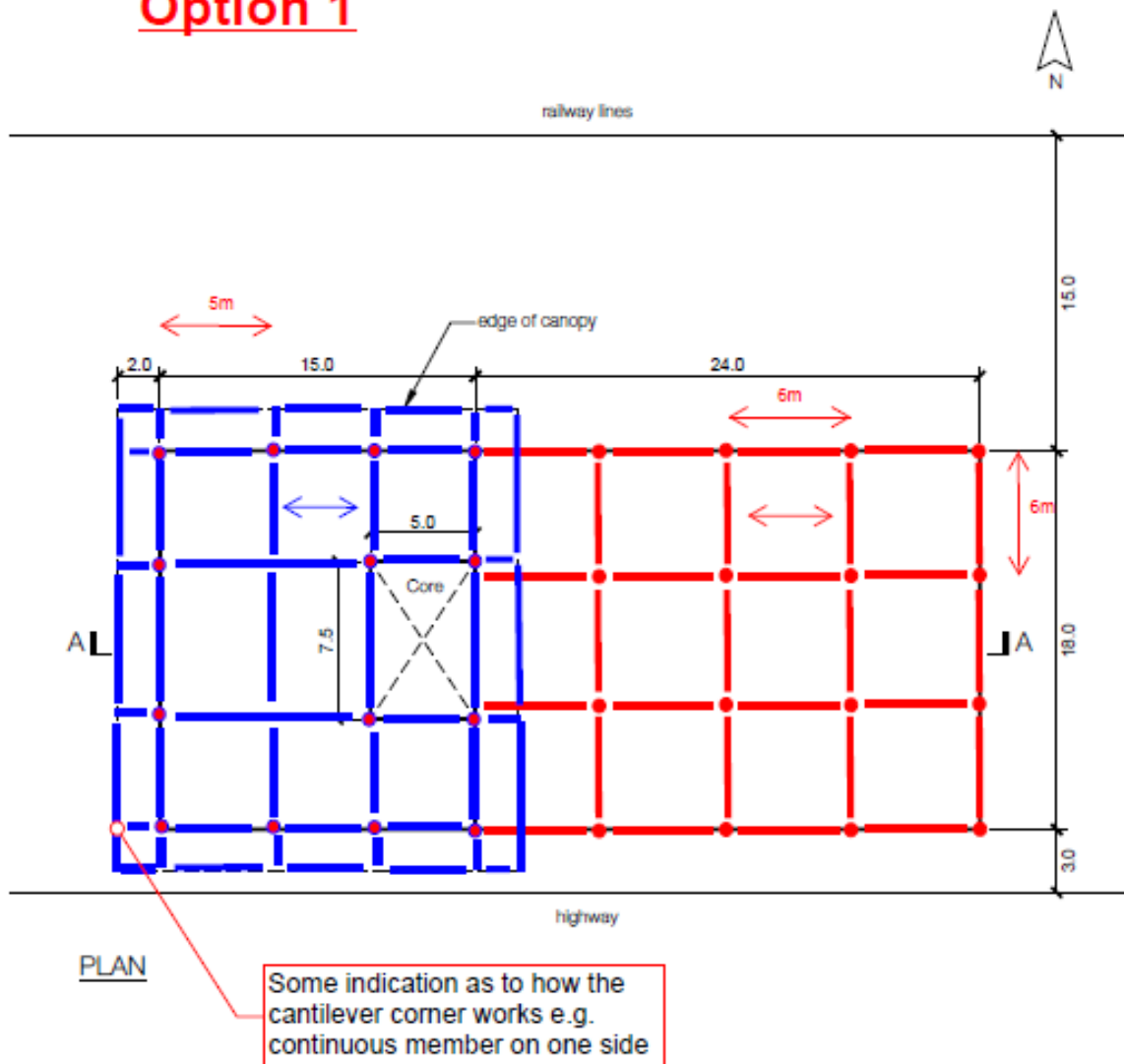
Mark up for:

- ▶ Discussing temporary works associated with retaining wall adjacent highway and issues of craneage/piling rig operation adjacent to railway.
- ▶ Discussing the lateral stability scheme and how this likely leads to torsion.
- ▶ Consideration of glazing/structure interface and nature of overhanging roof canopy.
- ▶ Acknowledgement of waterproofing requirements.

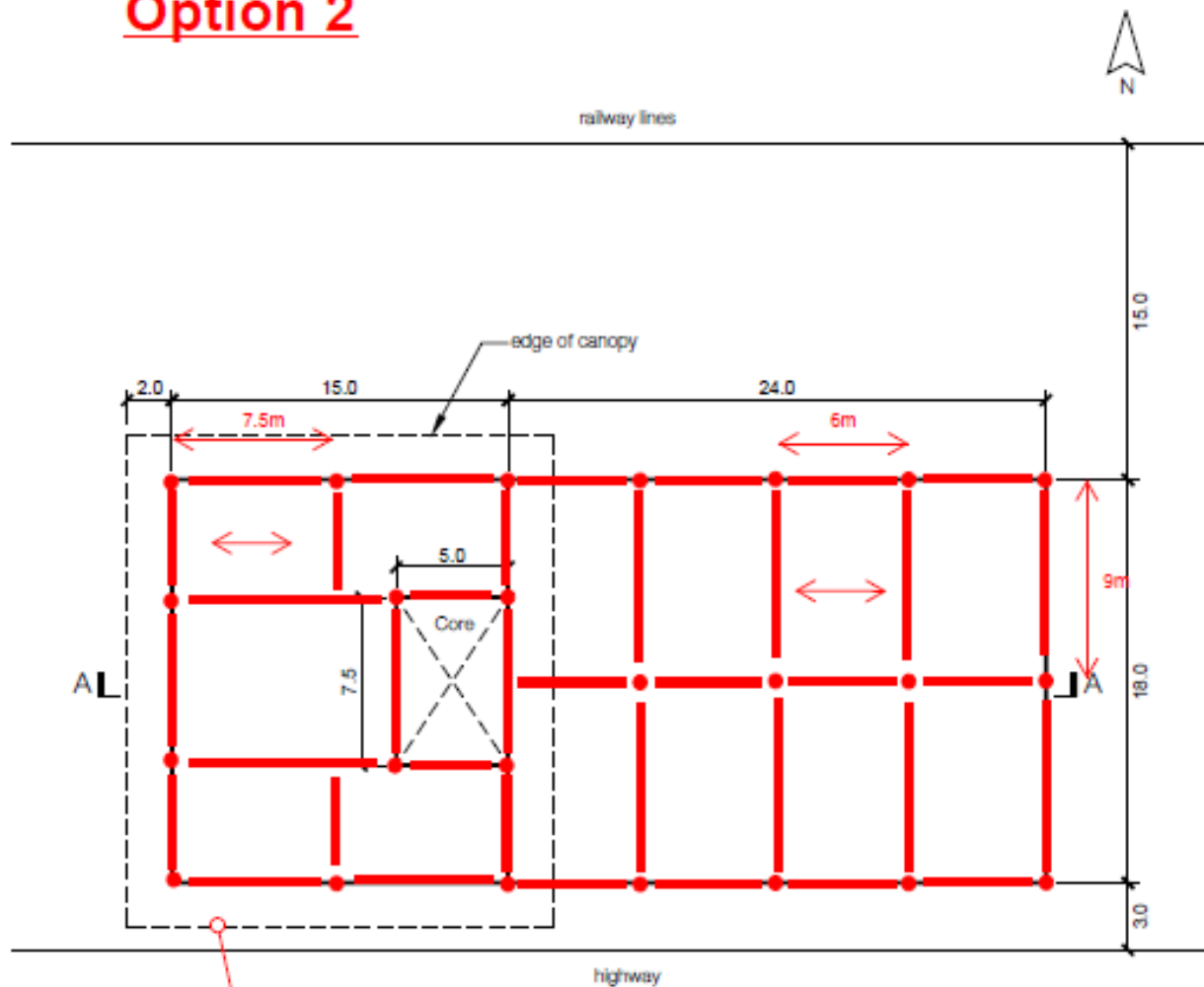
Mark down for:

- ▶ Internal columns less than defined spacing, unless noted as being in classroom wall lines.
- ▶ External columns below roof canopy.
- ▶ Lateral stability provision to the glazed façade of the upper ground floor area.
- ▶ Excessive structural depths.

Sketches

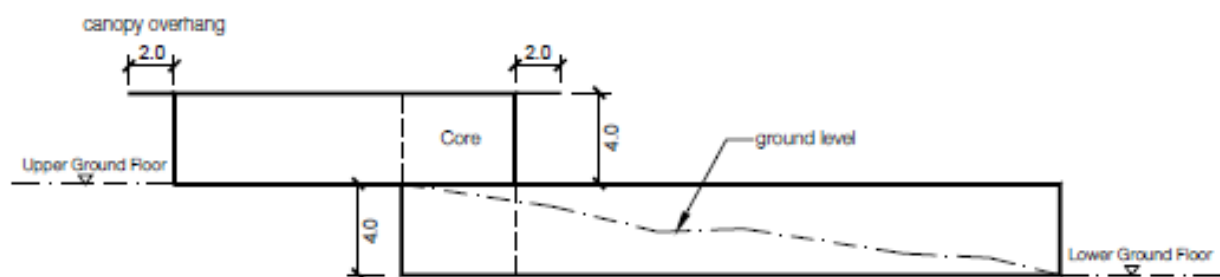
Option 1

Option 2



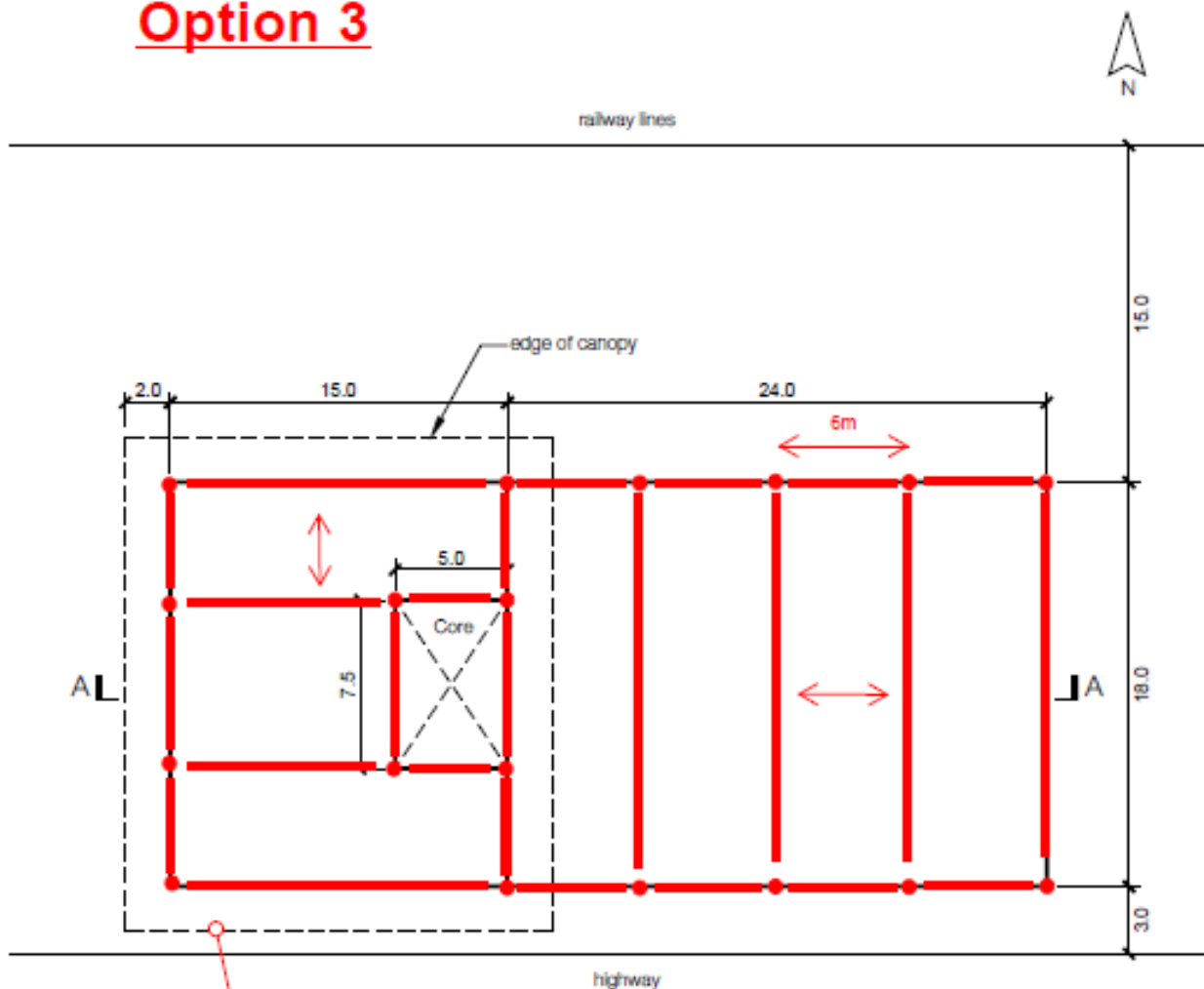
PLAN

Cantilever anticipated to be similar on both schemes, but follow the primary member supporting arrangement



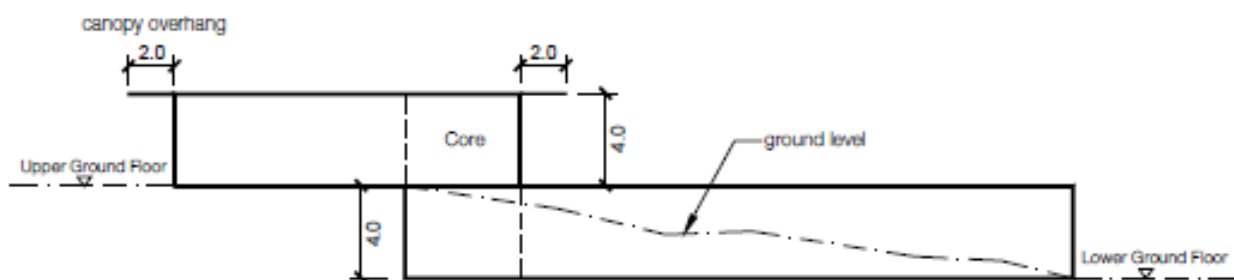
SECTION A-A

Option 3



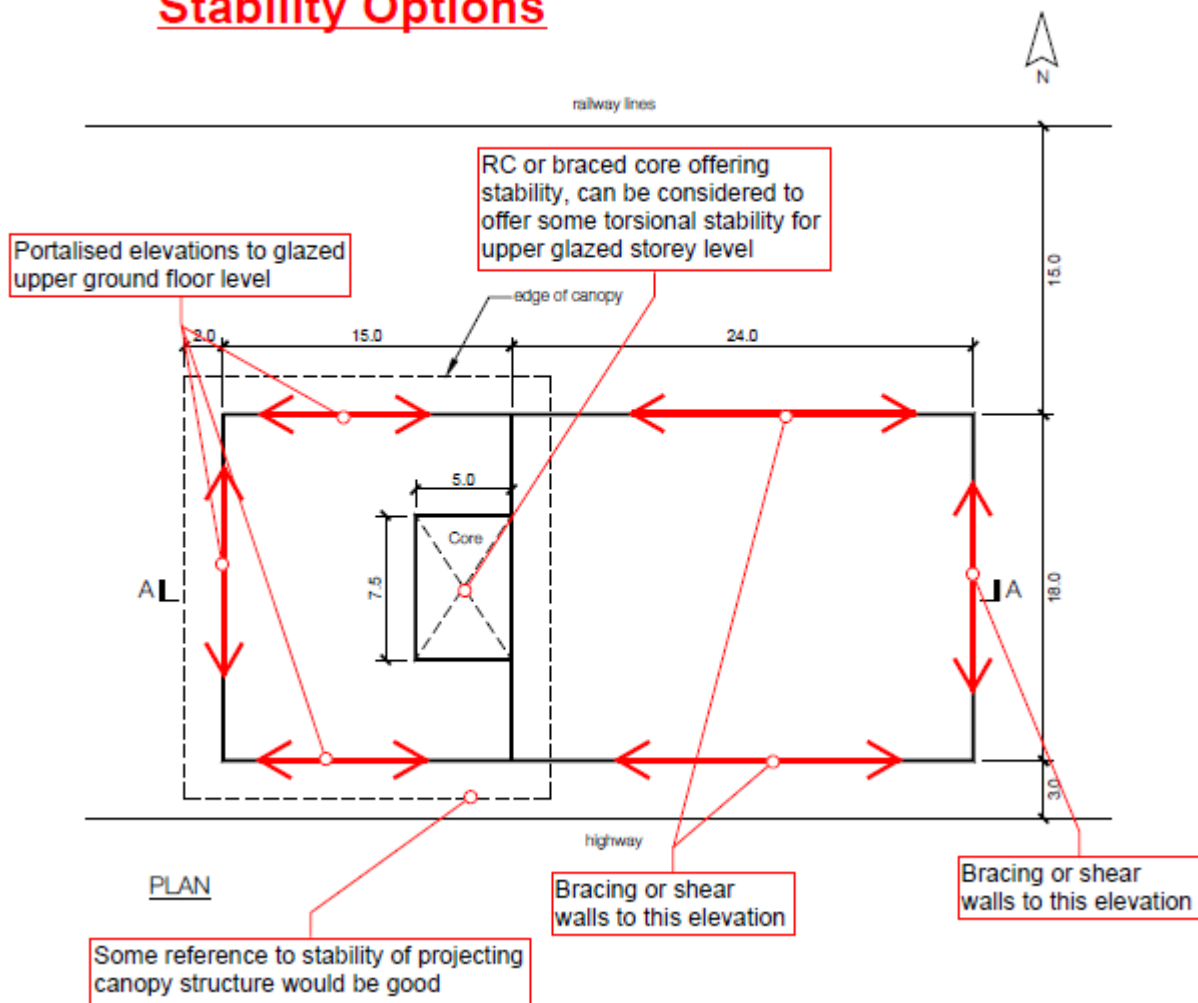
PLAN

Cantilever anticipated to be similar on both schemes, but follow the primary member supporting arrangement



SECTION A-A

Stability Options



Section 1b – changes to the brief for reduction in material usage options

The letter requires the candidates to consider the implications of making the scheme more efficient whilst generally maintaining the column free spaces. This could include:

- ▶ More structure between the classroom spaces described at lower ground floor level.
- ▶ Reduction of internal floor slab loadings, although this would only really be beneficial to reduce surcharge on the internal retaining wall line between levels.
- ▶ Reduction of external roof terrace loading (both dead and imposed).
- ▶ Reduce limitation on structure to the glazed façade and allow for bracing members
- ▶ Reduce limitation on slim roof projection, either to make deeper, allow perimeter support or reduce in length.
- ▶ Reduce the amount of excavation works by moving the development to the east or building above ground rather than below ground.

Section 2c – calculations

The candidate should be able to identify the critical design components for each section of the building and provide the appropriate calculations. The actual calculations would depend on the scheme chosen, but anticipated to include:

- ▶ Retaining wall
- ▶ Foundation
- ▶ Column
- ▶ Stability
- ▶ Lower ground floor roof structure
- ▶ Upper ground floor roof structure, including projecting canopy.
- ▶ A1-A3 carbon calculations are required for each of the primary elements

Section 2d - drawings

What do you expect candidates to detail here? What plans/part plans, sections, elevations are crucial to the scheme design?

- ▶ Lower ground floor/foundation plan
- ▶ Upper ground floor foundation plan/external roof terrace
- ▶ Upper ground floor roof
- ▶ Section through upper ground floor
- ▶ Section through lower ground floor

All member sizes should be included for estimating purposes. Comments on waterproofing measures to suit retaining walls adjacent internal teaching space would be nice to see.

Section 2e – method statement

What are the key aspects of the construction process candidates need to include?

The method statement must consider all the constructional sequencing including any temporary works that may be required and be a clear indication that the candidate is familiar with normal site procedures. It is hoped that candidates will focus on the specific issues posed by the question i.e. construction in the vicinity of the highway and also railway line. There is scope to limit extent of temporary works to just highway elevation and use simpler open cut within site. Discussion on waterproofing techniques, especially where temporary works may limit access to rear of retaining walls to apply waterproofing measures.