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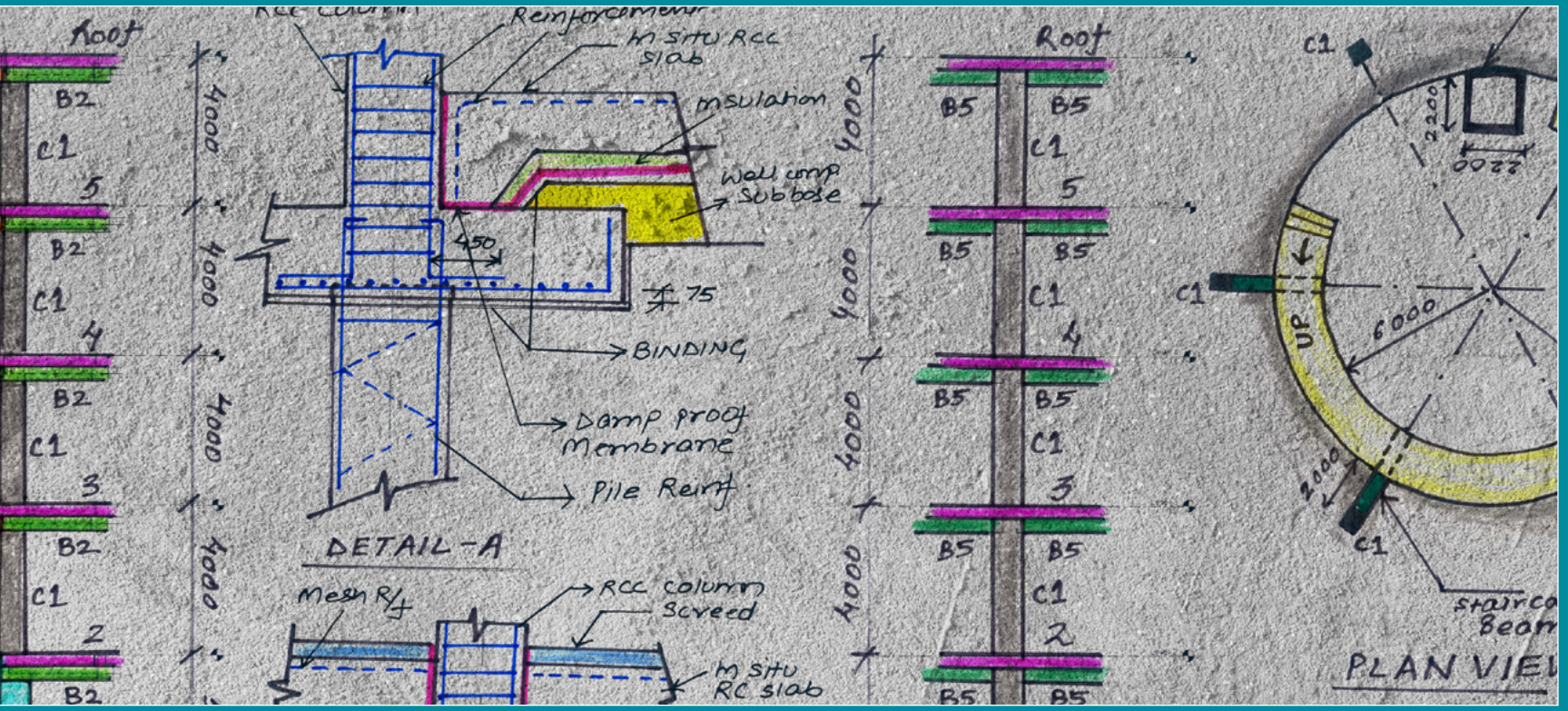
mpa The Concrete Centre

Structural Concrete 2024



The Concrete Centre Student Design Competition

Contents

mpa The Concrete Centre

The Concrete Centre provides material, design and construction guidance. Its aim is to enable all those involved in the design, use and performance of concrete to realise the potential of the material as a long lasting and sustainable choice. The Concrete Centre provides published guidance, seminars, courses, online resources and industry research to the design and academic communities. For more information on The Concrete Centre visit **www.concretecentre.com**.

The Concrete Centre is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and industrial sand industries.

LAING O'ROURKE

Laing O'Rourke is is a globally diverse engineering and construction group with a commitment to delivering Excellence Plus performance, founded on over 170 years of experience. They fund, design, manufacture, construct and maintain the modern world – providing the buildings and infrastructure to accommodate, educate, employ, transport, care for and sustain communities.

Their business comprises the full range of engineering, manufacturing, construction and project management services. Their fully integrated offering delivers bespoke solutions to meet the requirements of some of the world's most prestigious public and private organisations. Their collaborative approach combines discipline in delivery with the continuous pursuit of innovation: engaging with customers and partners at the earliest stages, advising on and providing the best ways to complete projects with certainty and achieve greatest value for all stakeholders – employees, customers, communities and shareholders. Their long-term strategy aims to create sustainable growth by meeting the economic, social and environmental challenges of the rapidly changing world. Their pursuit of engineering excellence is supported by their investment in innovative industry-leading precast concrete and offsite manufacturing facilities.

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More information is available online at:
www.laingorourke.com

Introduction

Structural Concrete 2024 sets a demanding challenge for all students studying structural design as part of UK University BEng, MEng and MSc degree courses in Civil and/or Structural Engineering.

This student design competition aims to encourage interest and raise competence in designing with concrete. The competition offers a stimulating and fun challenge to students, while supporting the curricula of civil and structural engineering departments of UK universities. The main benefit for a student is in being able to present their work to prospective employers, some of whom are involved in setting and judging the competition. The national winners will be presented with their prizes at an event in London where their award-winning entries will be presented to the audience.

There will also be a sustainability award for the student/team who demonstrates the best understanding of this subject in their submission.

These awards reflect a significant commitment from the judges who, together with The Concrete Centre, have carefully developed this year's competition. Initiative, creativity, aesthetic appreciation and accuracy are called for, and will be assessed by the judges. Above all, this competition has been designed to stretch the technical competence of the students taking part.

Because it is so flexible, Structural Concrete 2024 can easily be incorporated into existing university curricula, with content that reflects an independent project, a group project or a module assessment run over the first, second or both semesters of the academic year.

DOWNLOAD ENTRY FORM

This year's challenge…

The 2024 project is a new building to house the art collection of a well-known public figure who has donated it to her hometown. The celebrity has also donated the funds to build the new development and would like the building to be able to act as a hub for the arts and the community.

The structure is to provide space for the art collection, visiting art collections, function rooms, a café and offices for the curating staff.

The client has appointed a project manager to turn her dream into a reality. The project manager has commissioned an initial structural design for the development, to be known as the Taylor Art Hub, from a firm of consulting engineers. The building is to be situated in the centre of the town and has a one-storey basement and four-storey superstructure.

Entrants must respond as though they are the structural engineer responsible within the consultant's team.

Exposed concrete at the Tate Gallery, London. Image: David Parker/Alamy Stock Photo

1. Project brief: Taylor Art Hub

The Taylor Art Hub is to be constructed on a brownfield site in the centre of a town in the Northeast of England. The brief requires a four-storey superstructure on a one-storey basement. The client has commissioned an initial structural design from a firm of structural engineers.

The proposed building is 45m x 75m long, with two wings on either side of a tall exhibition space. No restriction on the spacing of the columns is given, but the function rooms should have as few columns as possible, with a wish from the client to have these spaces column free. No columns are allowed in the central atrium exhibition space but are allowed in the rest of the exhibition space. Figures 1 – X give the layouts and cross sections for the building.

Table 1 gives the minimum floor to soffit in the different spaces together with the imposed load to be taken.

Space	Floor to soffit height (m)	Imposed load (kN/m^2)
Storage and Plant	3	5.0
Exhibition space	4	4.0
Offices	3	3.5
Community hub	3	3.0
Function room	4	5.0
Café	4	2.0
Roof	-	0.75

Table 1: Information on the heights and loading required.

Planning considerations dictate the use of fair-faced or architectural precast concrete cladding panels on the facade. These facades will be punched precast concrete cladding panels with 30% glazing. Because the high-quality cladding forms a significant component of the cost of the building, the depth of floor construction should be considered carefully, taking into account cost and material efficiency.

The structure is to be reinforced concrete (either in-situ, precast or hybrid concrete construction) and clad in precast concrete. The client would welcome proposals from the structural engineer that might enhance the visual appeal of the building and improve the speed of construction.

Staircases and lifts are required in both the wings of the building and can be located as required. Two staircases and three lifts should be provided in each of the wings. One of the lifts in the wing containing the function rooms must be a goods lift capable of transporting pieces 3m x 3m with a weight of 1 tonne.

The external walls to the atrium space are to be constructed in lightweight glazing. The roof over the atrium is to incorporate glazing and can be constructed in lightweight materials.

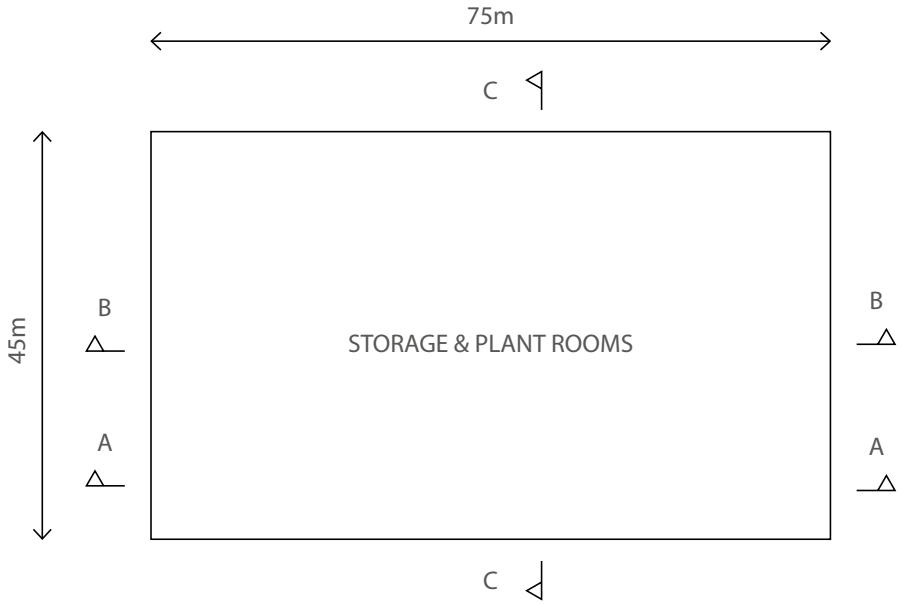

Figure 1: B1 Level

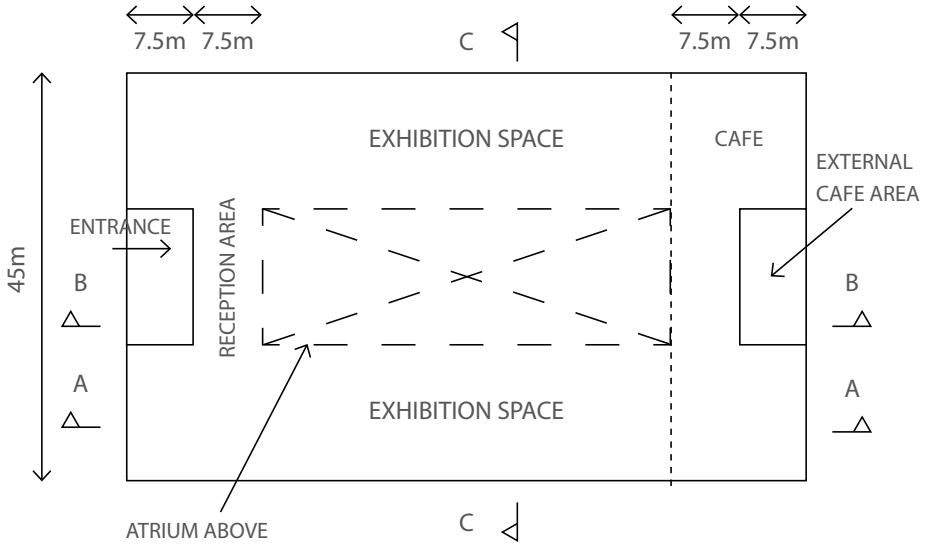

Figure 2: Ground Floor Level

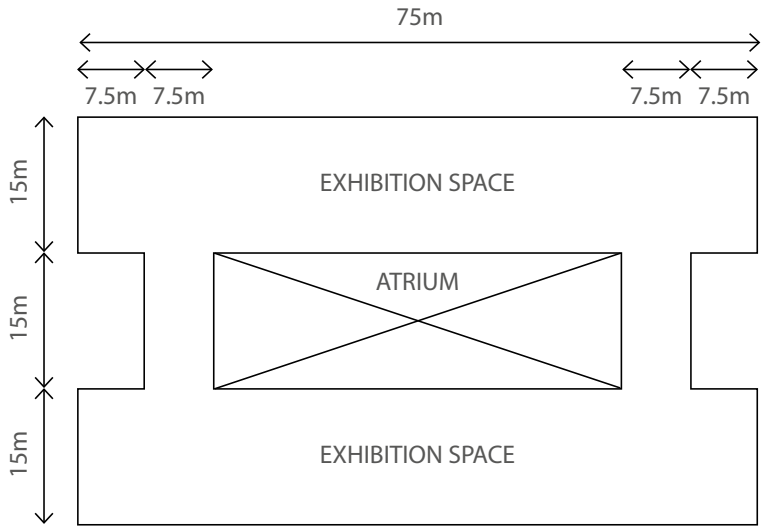

Figure 3: First Floor Level

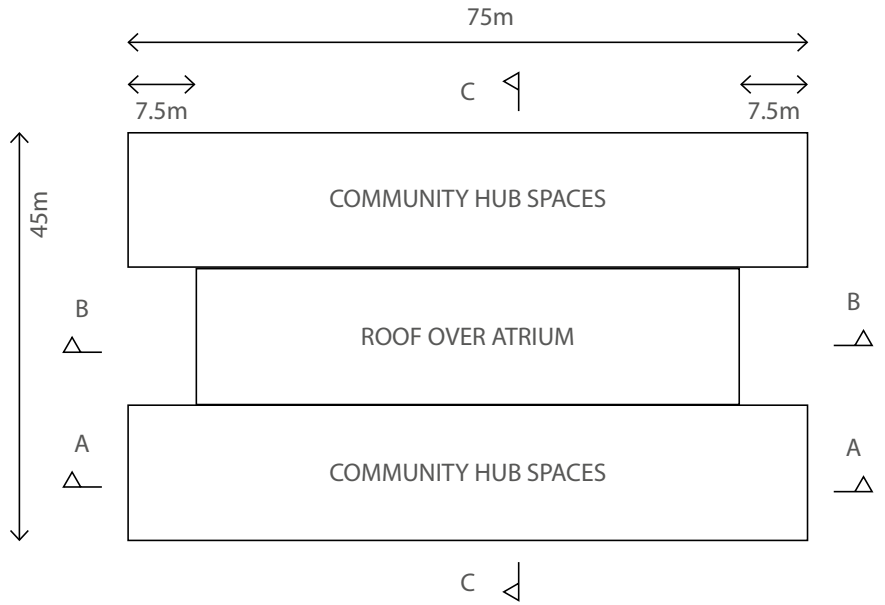

Figure 4: Second Floor Level

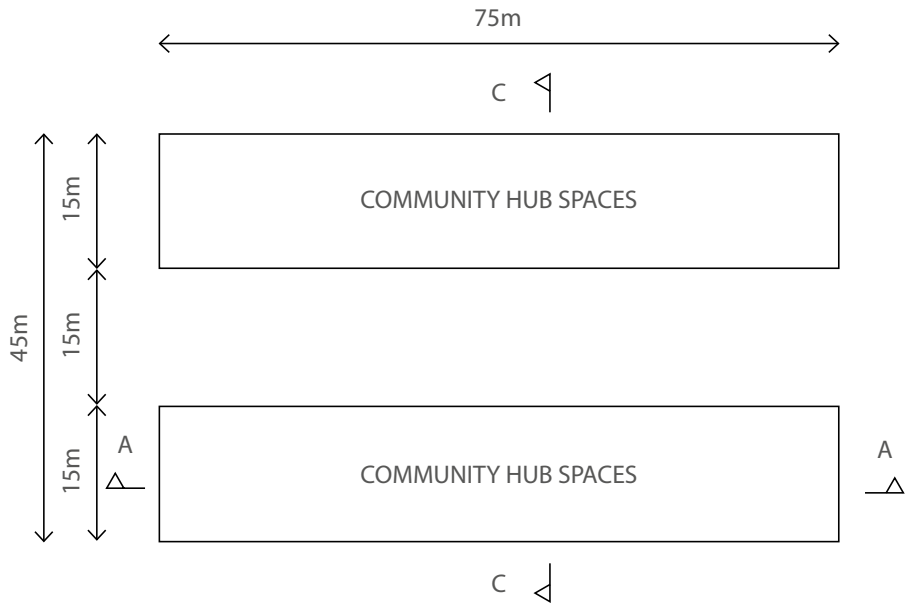

Figure 5: Third Floor Level

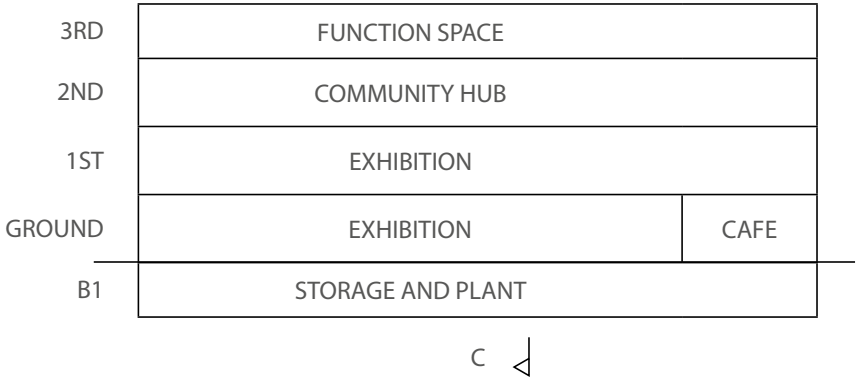

Figure 6: Section A-A

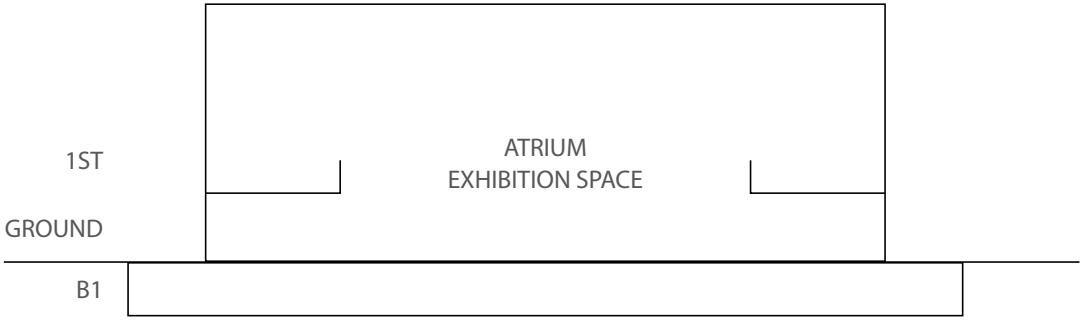

Figure 7: Section B-B

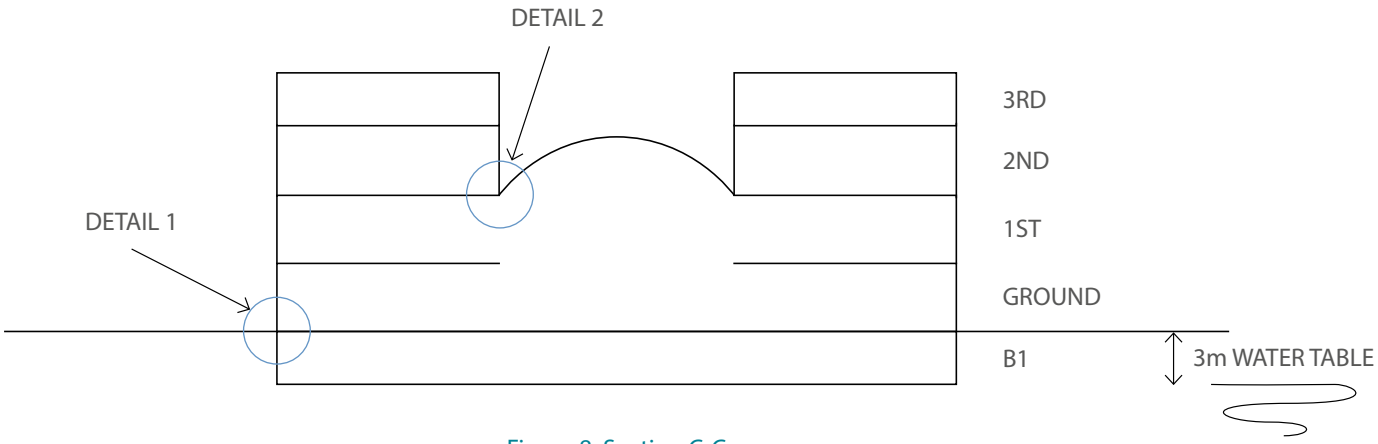

Figure 8: Section C-C

2. Design data

Verification of structural viability should be carried out in accordance with current Eurocodes. Entrants should clearly state in their submission which documents have been used in their calculations. Materials specifications should be defined to the current British Standards. Fire resistance of 90 minutes is required.

2.1 Loadings

2.1.1 Dead loads

Dead loads of structural elements as found.

Cladding:	
Precast concrete cladding	2.4 kN/m^2
Glazing	0.70 kN/m^2

2.1.2 Imposed loads

In addition to the loads given in Table 1 an allowance for services, flooring and ceiling combined should be taken as 0.5kN/m^2. The exhibition space should also be designed to take a point load of 10kN over an area of 300mm x 300mm anywhere on the floor.

All values are characteristic values.

2.2 The site

2.2.1 Exposure conditions

The Taylor Art Hub is to be constructed on a brownfield site in the centre of a town in the Northeast of England.

The site is level, situated 5km from the edge of the town and 25km from the nearest sea.

The fundamental wind speed $v_{b,map}$ should be taken as 23m/s (based on BS EN 1991-1-4:2005). Snow loading may be neglected.

2.2.2 Ground conditions

Description	Depths below ground level	Soil data
Made ground	GL to 3.0m	
Sandy clay	From 3.0m to 20m	c = 100kPa
Rock	Below 20m	N=30

Ground water was encountered at approximately 3.0m below ground level.

3. Submission requirements

The submission is to comprise four components:

i. A conceptual design report

ii. Appendix 1 containing calculations for the selected scheme

iii. Appendix 2 containing the drawings for the selected scheme

iv. Appendix 3 containing a sustainability appraisal.

The submission must not exceed 60 single sided A4 pages and three A3 size drawings.

3.1 Conceptual design report

A maximum of 30 pages, of either 1.5 line spaced text in a maximum 11pt font, or neatly hand written in black ink, which should include:

i. An appraisal of two distinct and viable design solutions in structural concrete for the building, together with their associated slab, beam, column, wall and roof layouts. The appraisals should comprise sketches of typical bays with supporting notes, outlining the intended load paths, framing and stability functions, and some brief notes on construction methodology. The appraisal should include consideration of any uplift forces on the structure.

i. An evaluation of the merits and disadvantages of the two solutions. The evaluation should identify significant differences such as cost, buildability and material efficiency between the two alternatives, and make a recommendation in favour of one solution.

ii. A description of the foundation scheme adopted for the preferred solution, with a rationale for the selection. A fully detailed design for the foundation scheme is not required.

iv. An outline specification for concrete and reinforcing materials.

v. A method statement for a safe construction procedure for the building.

vi. A statement of how robustness to avoid disproportionate collapse is satisfied.

vii. After completion of your design, the site is flooded, and the client asks what would be needed to build in resilience against flooding. Reply to their letter outlining what could be achieved and how this would change the design of the structure.

3.2 Verification of structural viability

The verification of structural viability of the selected scheme should be demonstrated in Appendices to the conceptual design report to make up the balance of the report. (The maximum total length of the design report, sustainability appraisal plus Appendix is 60 pages A4. This does not include references or title pages.)

The Appendices should contain sufficient design calculations by hand to establish the form and size of all structural elements for the chosen scheme. Entrants should decide how best to convey this information within the space constraints imposed.

Calculations for individual elements should enable a checker to understand clearly their contribution to the strength and stability of the whole structure, and the load paths assumed. Hence, if computer output is presented, validation by (approximate) hand calculations is also required. Consideration should be given to performance at both Serviceability and Ultimate Limit States.

Note: Calculations are not required for stairs.

3.3 Drawings

A total of three A3 drawings should be included. Drawings may be prepared using appropriate CAD software, or by hand. In either case, notes and dimensions should not be smaller than the equivalent of an 11pt font. These drawings need not be counted in the 60-page limit.

Two of the A3 drawings should be used to present general arrangements, sections and elevations of the building to show the layout, disposition and dimensions of structural elements for estimation purposes. Drawings should be to an appropriate scale and must be dimensioned. Reinforcement details should not be shown on these two drawings.

The third drawing should show the reinforcement detail at the junction of the basement retaining wall and ground floor; and the detail of the fixing arrangement for a precast concrete cladding panel and atrium roof. These locations are shown in Figure 8.

3.4 Sustainability plan

The Client has required that the project manager provides them with a report on the sustainability aspects of the project. It is important to her that the building has a long-design life, is low maintenance and is resilient to flooding and climate change impacts.

Prepare a section on the structure to be included in the sustainability statement, including any mitigating measures taken in the specification of the structure, and including sustainability aspects such as fire safety and fabric protection, material efficiency, whole life carbon and resilience.

4. Assessment criteria

4.1 University

The competition will operate on two levels. Firstly, all submissions made at each university will be judged by the academic tutor(s) involved with the project. The winning submission from each university should then be entered for the national level of the competition by the tutor or a member of the team.

Only one entry from each university can go forward for final judging at a national level and the entry form must be signed by the appropriate tutor.

4.2 National

The winning entry from each participating university will be judged at national level using the following generic assessment criteria:

- Compliance with the project brief
- Safety, function, stability and robustness
- Buildability, constructability and maintainability
- Speed of construction and cost effectiveness
- Imagination, flair, aesthetic appreciation and innovation

The interpretation of the above criteria by the award judging panel will be final and feedback will not be provided.

5. Awards

5.1 University level

The winning entry from each university will receive a prize of £250. This entry will go forward to compete at national level.

5.2 National level

The winner(s) of the national competition will receive a certificate(s) and a prize of £1,250.

Runner(s) up will also receive a certificate(s) and a prize of £750. *The judges may decide on joint prizes in which case the above prize money will be divided up by the judging panel at its discretion.*

A special commendation, certificate and prize of £250 will be available for the best sustainability report.

The prize-winners' universities will also receive certificates.

5.3 Presentation

The winners will be announced in a webinar to be held in August 2024. The prizes and certificates will then be presented to the winner(s), runner(s) up and winner(s) of the special commendation at an awards ceremony in London. This will be part of a seminar for practising engineers who will be able to review the winning entries. The prize-winners will be notified of further details.

5.4 Eligibility

Structural Concrete 2024 is open only to students studying for a degree at a UK university. Entries can be single, joint, or from teams of up to four students. Although the competition is aimed at students in their final years of study, entries from any other appropriate undergraduate and/or postgraduate stages will also be considered at the discretion of the academic tutor(s).

6. Rules

I. To enter the competition the university academic tutor(s) should register the university's intention to participate by either filling in the online form at www.concretecentre.com/competition or emailing The Concrete Centre at info@concretecentre.com. Registration will enable The Concrete Centre to provide supplementary information and/or assistance if needed.

II. The completed entry form naming the local winner should reach The Concrete Centre by either submitting online or email by Friday 14th June 2024. On receipt, The Concrete Centre will issue each competitor with a unique entry reference number.

III. Complete design entries must be received by email or into The Concrete Centre Dropbox (details will be provided to those submitting an entry), by the final deadline of 4pm on Friday 12th July 2024. The entry reference number should be clearly marked on all items forming the design entry. No other form of identification or distinguishing mark should appear on any part of the submission.

IV. A successful competitor may be required to satisfy the judges that he or she is the bona fide author of the design that he or she has submitted.

V. Any entry shall be excluded from the competition if:

- The competitor does not meet the eligibility requirements detailed in Section 5.4
- The entry is received after the competition closing date in rule III above
- The competitor discloses his or her identity, or that of the university, in the submission
- The competitor attempts to influence either directly or indirectly the decision of the award judging panel

Entry Form

Structural Concrete
Student Design Competition 2024

To be submitted by no later than 14 June 2024. This form is to be completed only for the entry which has been marked and selected by the academic tutor(s) for submission to the national competition. Only one entry will be permitted from each university.

University	
Name and email address of Academic Tutor(s)	

1. *I/We have complied with and accepted the rules which apply to this competition
2. *I/We agree to accept the decision of the judges as final, and agree to permit free publication and exhibition of *my/our work
3. *I/we declare that the design is *my/our work and that the drawings have been prepared by *myself/ourselves.
4. *I/we agree that any part of this work may be reproduced in publicity or other materials by The Concrete Centre as required.

*Delete as applicable

Signature student(s): .....

Signature academic tutor(s) .....

This form is to be completed by the competitor(s) and academic tutor(s) and submitted online or via email to info@concretecentre.com. An entry reference number will then be given, which should be marked clearly on all items forming the design entry.
No other form of identification or distinguishing mark should appear on any part of the submission.

Please return to:
info@concretecentre.com

The following student or student team (maximum of four students per team) will represent the university:

Student Name			
Home Address			
Email			
Phone		Year	

Student Name			
Home Address			
Email			
Phone		Year	

Student Name			
Home Address			
Email			
Phone		Year	

Student Name			
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