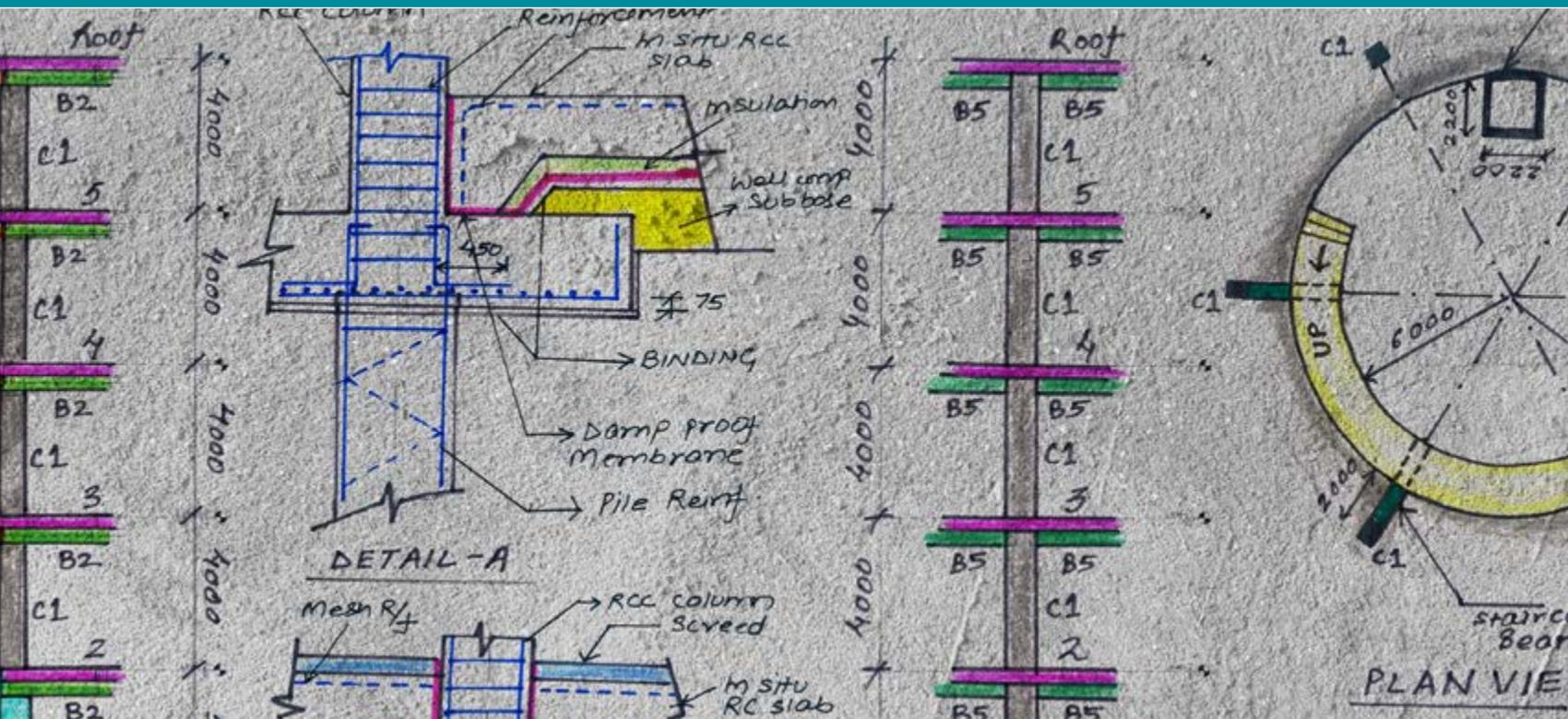


Structural Concrete 2023



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The Concrete Centre is the central development organisation for the UK cement and concrete industry. Its objective is to assist all those involved in design and construction to realise the full potential of concrete as an adaptable and sustainable construction material.

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 silica sand industries.



Laing O'Rourke 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 model comprises the full range of engineering, manufacturing, construction and project management services. Their fully integrated offering delivers bespoke solutions to meet the particular 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.

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

Introduction

Structural Concrete 2023 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 shown. There will also be a sustainability award for the student 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 2023 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.

This year's challenge...

The 2023 project is a new office building with basement car parking in a city centre in the North West of England.

The structure is to provide a new home for a multi-disciplinary company, including six storeys of office spaces with basement car parking.

The client, a property developer, has commissioned an initial structural design for the development, to be known as Beeby House, from a firm of consulting engineers. The building includes a basement with office car parking and six floors of office space. Entrants must respond as though they are the structural engineer responsible within the consultant's team.



*Exposed concrete at White Collar Factory, a recent office building in London.
© Tim Soar Photography*

1. Project brief: Beeby House

Beeby House is to be constructed on a brownfield site in the centre of a major city in the North West of England. The brief requires a six-storey high office building with basement parking.

The new building comprises basement car parking and six floors of open plan office spaces. The client, a property developer, has commissioned an initial structural design from a firm of consulting engineers.

The proposed building is in the shape of a 81m long × 25m wide ellipse. This comprises office spaces, plantrooms, stairs and lifts. The client requires an open office space and has requested that the columns be at a minimum spacing of 8m (centre to centre).



Access from the basement to the upper floors will be via lift or stairs located in the main core(s) of the building, which will occupy 4% of the total floor area on each floor. The minimum floor to soffit of structure height is 2.9m. The maximum floor to floor height is 3.8m. The intended ground floor layout is shown in Figure 1.

The basement will provide 20 car parking spaces including five disabled car parking spaces. Space for 40 bicycles should also be included in the basement. Vehicle access to the basement car park will be via a ramp at the west end and egress will be via a ramp on the east end of the building. The ramps are external to the footprint of the building. Retaining walls will be required around the perimeter of the basement and the ramps. Columns should be located in the basement to suit the parking layout. No columns are allowed in the aisles. A floor to soffit height of 2.6m is required throughout the basement.

At roof level, all servicing plant including water tanks, heating boilers and lift mechanism are to be located on top of the core(s) and screened by a 3.0m high enclosure on external faces. The enclosure screen itself does not have to be designed.

Planning considerations dictate the use of faced 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 as small as practicable to minimise the overall height of the building.

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.

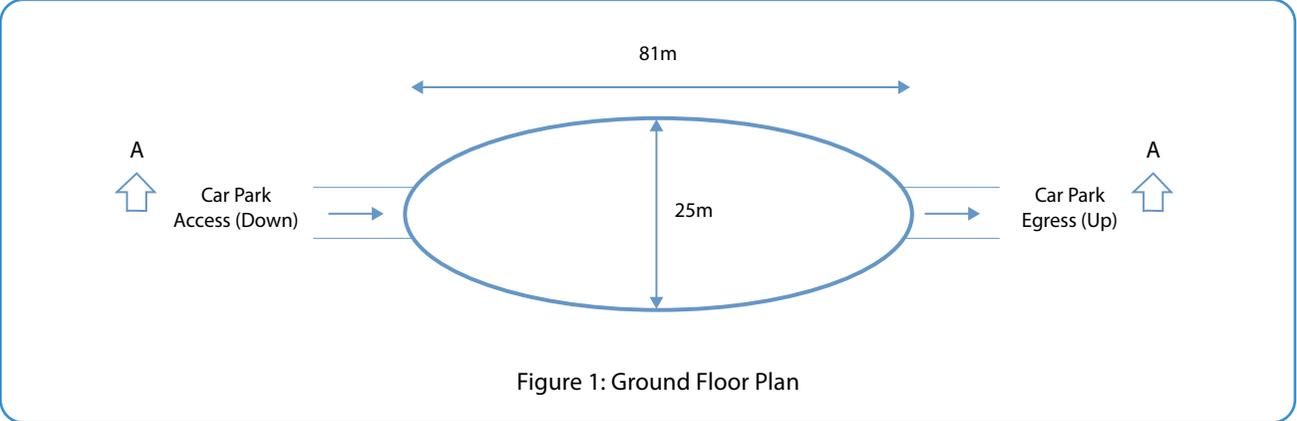


Figure 1: Ground floor plan

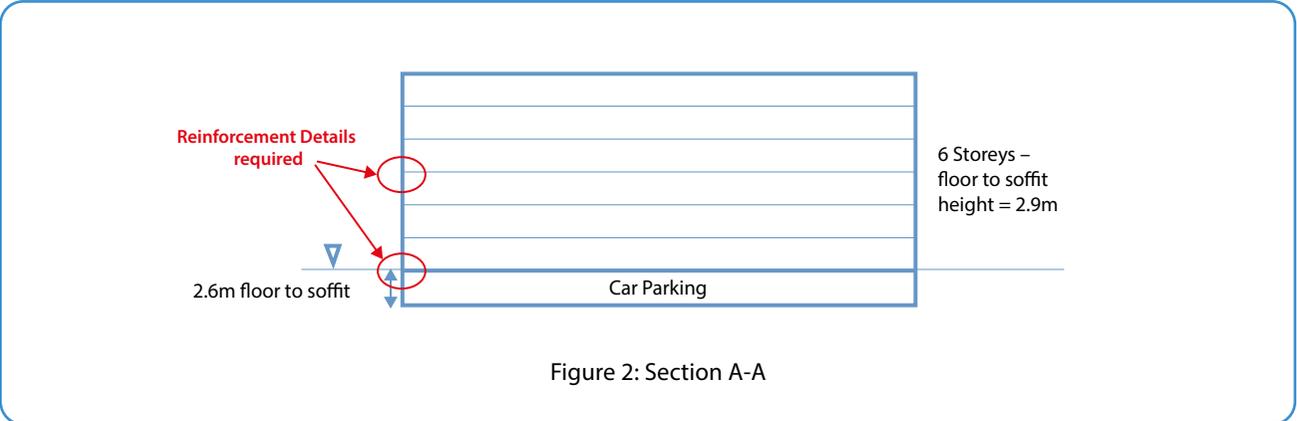


Figure 2: Section A-A

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 loadings

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 loading

Imposed loading:	
Plant room	7.5 kN/m ²
Other areas of roof not zoned for plant	0.75 kN/m ²
Office area floors, including partitions	2.5 + 1 kN/m ²
Basement	2.5 kN/m ²

These loadings do not include an allowance for raised floors, ceilings and services. All values are characteristic values.

2.2 The site

2.2.1 Exposure conditions

The site is level, situated 5km from the edge of the city and 30 km from the nearest sea.

The fundamental basic wind speed, $V_{b,map}$ should be taken as 21m/sec (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 1.0m	
Sandy clay	From 1.0m to 16m	$c = 50\text{kPa}$
Rock	Below 16m	Allowable bearing pressure 2500kPa

Ground water was encountered in sample boreholes at approximately 3.5m. There may be seasonal variations in groundwater level, but monitoring of one standpipe over the period Oct-April shows a maximum groundwater level of 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 a diagram of the parking layout in the basement.
- i. An evaluation of the merits and disadvantages of the two solutions. The evaluation should identify significant differences such as cost or buildability 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 client writes to you to ask for 60 car parking spaces in the basement. Reply to their letter outlining how this change could be achieved and how it would affect 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.)

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.

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. These locations are shown in Figure 2.

3.4 Sustainability plan

The Client is required to provide a statement to their investors regarding the sustainability aspects of the project. It is important to the investors 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 and resilience.

4. Assessment criteria

4.1 Local

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.

Only one entry from each university can go forward for final judging at a national level.

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. The winning 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 prizes and certificates will be presented to the winner(s), runner(s) up and winner(s) of the special commendation at an awards ceremony in September 2023 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 2023 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 9 June 2023. On receipt, The Concrete Centre will issue each competitor with an entry reference number.
- III. Complete design entries must be received by email, by the final deadline of 4pm on Friday 7 July 2023. 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 2023

To be submitted by no later than 9 June 2023. 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)	

- *I/We have complied with and accepted the rules which apply to this competition
- *I/We agree to accept the decision of the judges as final, and agree to permit free publication and exhibition of *my/our work
- *I/we declare that the design is *my/our work and that the drawings have been prepared by *myself/ourselves.
- *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.**

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	
Home Address	
Email	
Phone	Year

Please return to: info@concretecentre.com



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