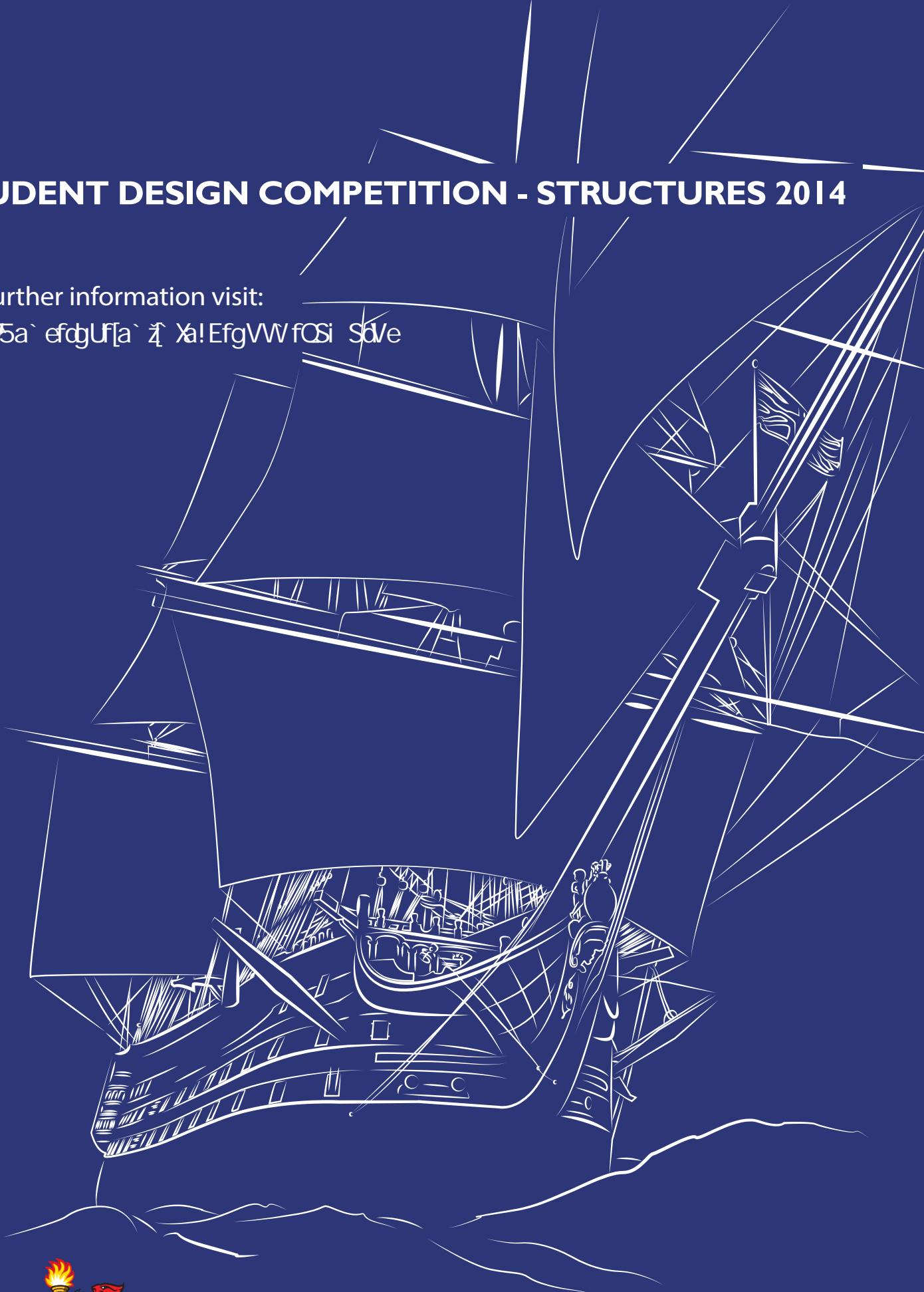


# STUDENT DESIGN COMPETITION - STRUCTURES 2014

For further information visit:

[www.bcsa.org.uk](http://www.bcsa.org.uk)



**TATA STEEL**



# Foreword

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The Tata Steel / BCSA Student Awards Structural Steel Design has been organised by The Steel Construction Institute, with the sponsorship of Tata Steel / BCSA, and is one of three popular Undergraduate Prize Award Competitions. The other competitions cover steel bridge design and architectural design. The objective of this competition is to encourage engineering design skills in the use of structural steelwork in an innovative structural solution. The brief has been formulated to encourage the entrants to realise the full structural, economic and aesthetic advantages offered by the use of both open and tubular structural steelwork profiles.

The competition is open to undergraduates. The project brief has been finalised in consultation with course tutors and those actively involved in designing, detailing and constructing steel structures.

The brief this year is to prepare an outline design for a structure to completely cover a historic ship, located in a dockyard as one of several visitor attractions. Entrants are expected to demonstrate individuality and flair in this competition, in addition to showing an understanding of structural design, and to communicate their ideas in a written report with calculations and drawings.

The brief was compiled by:

Mr D G Brown	The Steel Construction Institute	<i>Secretary</i>
Dr J B Davison	The University of Sheffield	
Mr M Denham	Elland Steel Structures Ltd	
Mr A Hughes	Consultant	<i>Chairman</i>
Mr C Smart	Tata Steel	

The award will be judged by:

Mr D G Brown	The Steel Construction Institute	<i>Secretary</i>
Mr M Denham	Elland Steel Structures Ltd	
Mr A Hughes	Consultant	<i>Chairman</i>
Mr A C Jones	Sinclair Knight Merz	
Prof R G Ogden	The Steel Construction Institute	
Mr C Smart	Tata Steel	

Tata Steel / BCSA and The Steel Construction Institute would like to express their gratitude for the continuing support of all those concerned.

# 1 THE BRIEF

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## 1.1 INTRODUCTION

A dockyard has been turned into a visitor attraction, housing a large number of maritime exhibits. One of the most well-loved exhibits is a historic sailing ship. In order to preserve the timber vessel, the ship must be enclosed to protect it from the environment. In addition to protecting the sailing ship, the project sponsors have a vision that the structure will, on one side only, provide very valuable multi-storey space for exhibitions and corporate events. Clearly, the maritime heritage of the area will play an important part in the design, which is to be in sympathy with the historic setting.

Because only an outline design is required at this stage, the functional requirements of the “events” building need not be explored in detail. At this stage, the client is primarily interested in proposals for the structural form of the enclosure for the ship and adjacent structure. Although to fully enclose historic ships in this way is novel, it is anticipated that this approach to conservation will become much more widespread.

## 1.2 APPOINTMENT AS CONSULTANT

You have been appointed as a structural engineer for the project and have been asked to work with the sponsor to prepare preliminary designs for a suitable structural solution for the ship enclosure and the adjacent building. The report is to contain the following scope:

1. A description of the structural arrangements for the structure. The report should outline with concept sketches the design process by which the final scheme was reached, and should describe the alternative schemes considered, and why these were rejected. The description of the structural arrangements must explain (with sketches as necessary) how lateral loads are transferred to the foundations, and demonstrate how lateral stability is maintained. In this description, the forces applied to the structure, and the internal forces, must be properly resolved.
2. A **clear recommendation** to the Client about the scheme selected, with reasons for your choice.
3. A **detailed structural design** for representative parts of the structure, including primary members and stability systems. The calculations must include an assessment of the elastic critical load factor for the structure, in appropriate directions.
4. A **schedule of loads** for foundation design.

## 1.3 DETAILS OF THE PROJECT

1. Site

The site can be considered a “brown field” site, but with no restrictions on the footprint of the structure, since the dockyard now has vast areas of flat space. The site is level, and exposed; shelter from surrounding buildings should not be assumed. The dockyard is of course immediately adjacent to the sea. There are no constraints on storage during construction.

The historic ship is already located in a dry dock. For the purposes of this scheme design, it can be considered that the ground level is effectively the original waterline of the ship. The dimensions and construction of the dock need not be considered; any necessary foundation work will be designed and completed by others.

## 2. General arrangement

The outline proposal from the client is that the ship enclosure and the adjacent building will comprise one structure. The adjacent building is to run along one side of the ship; port or starboard is equally acceptable. The clients trust that the ship enclosure will be as transparent as is possible, so that visitors will still be able to appreciate the ship from a distance from as many angles as is possible. Ideally, they would wish the adjacent building to be “transparent”, although it is recognised that structure will be required.

The maritime location and history of the site mean that some reflection of these themes is required.

## 3. Ship enclosure

The ship enclosure must provide as much visibility of the ship itself as possible. The ship itself can be described as falling within a three-dimensional shape, as detailed in Figure 1. All dimensions are in metres.

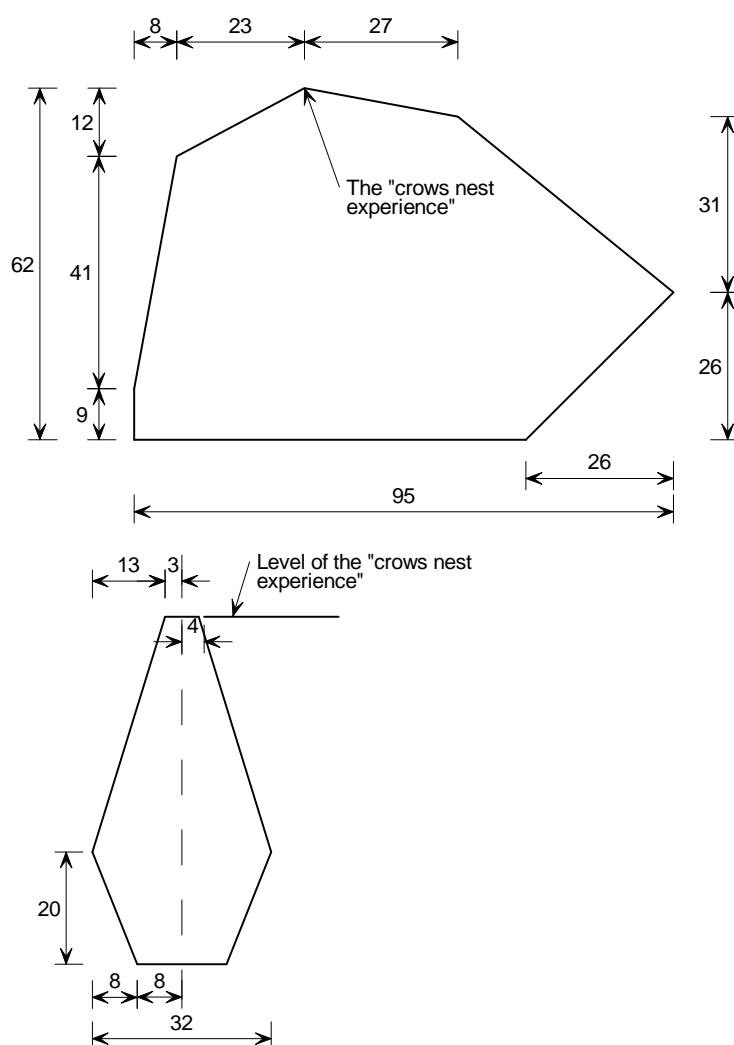


Figure 1 Elevation and cross-section of the historic ship

The ship enclosure is primarily designed to provide an air-conditioned weather-proof environment to prevent further deterioration of the ship's timbers. No consideration of the air-conditioning equipment is required in this proposal for a structural solution, although the submission should seek to balance the requirement for a transparent structure with the anticipated greenhouse effect. The keel of the ship runs North-South.

4. **Adjacent structure**

The client has no fixed views, and welcomes proposals. The client anticipates that the structure will be multi-storey, to provide several floors of useable space within a modest footprint. Although there is plenty of space on plan, the client feels that an extensive single storey structure is not appropriate. A multi-storey building may be a convenient way to gain access to the "crow's nest experience", described below.

The client would prefer flexible, open space, so wishes to maximise the column free areas. Stairs and lifts will be required, but there is no need to consider these in detail, other than to locate the necessary space.

5. **"Crow's nest experience"**

One critical feature of the scheme is to allow visitors an appreciation of the feeling of height, and the view, from the crow's nest. Although visitors cannot actually climb the main mast, the outline idea is to have an access platform at the 62 m level, which extends to 1 m from the ship itself (4 m from the centre line of the ship). These dimensions are shown in Figure 1. As much as is possible, whilst remaining entirely safe, this access must encourage the appreciation of the height to which sailors would have to climb. Normal disabled access requirements will apply to this platform.

6. **Construction**

Storage on site is readily available, and access straightforward. A proposed method of erection is an essential part of the report.

## **1.4 BASIS FOR DESIGN**

**a) Standards**

The entire works should be designed in accordance with the requirements of Eurocode 3: Part 1.1: 2005. Recommendations in the UK National Annex(es) should be adopted.

**b) Materials**

The structure should be designed using Advance rolled sections (S275 or S355) or Celsius hollow sections.

**c) Loading**

**i) Dead**

Self-weight of the structure as calculated.

**ii) Imposed Load**

The imposed load on any roof or exposed surface should be taken as  $0.6 \text{ kN/m}^2$ . Imposed roof load need not be considered on any slope steeper than  $60^\circ$ .

**iii) Imposed floor load**

The imposed floor load should be taken as  $5 \text{ kN/m}^2$  on any floor.

**iv) Services**

An allowance of 0.50 kN/m<sup>2</sup> should be made for services.

**d) Wind**

A dynamic pressure of 1.2 kN/m<sup>2</sup> is to be taken. Pressure coefficients may be determined from The NA to BS EN 1991-1-4:2005 + A1:2010

**e) Deflection**

Deflection limits may be taken from the UK National Annex to BS EN 1993-1-1

**f) Dynamic behaviour**

The dynamic response of the structure should be considered. The natural frequency of the structure should be calculated or estimated. The report should contain a discussion of the significance of the dynamic response and any measures incorporated in the design to manage the response.

**g) Floor construction**

Details of the floor construction must be given in the report.

**h) Other Design Requirements**

Frame stability must be checked in accordance with EC3, and  $\alpha_{cr}$  calculated in appropriate directions.

Special attention must be paid to arrangements to resist lateral loads and provide frame stability.

Proposals for cladding, insulation and arrangements to mitigate solar effects should be given in the report as appropriate.

**i) Foundation loads**

Although foundations will be by others, a schedule of foundation loads must be provided.

**j) Construction**

Submissions should contain a description of the erection method, highlighting any critical phases during construction.

## **1.5 ADDITIONAL RESOURCES**

The following resources are available for reference:

[www.tatasteelconstruction.com/en/products/structural\\_steel/](http://www.tatasteelconstruction.com/en/products/structural_steel/)

[www.tatasteelconstruction.com/en/products/roofs/](http://www.tatasteelconstruction.com/en/products/roofs/)

[www.tatasteelconstruction.com/en/products/walls/](http://www.tatasteelconstruction.com/en/products/walls/)

[www.tatasteelconstruction.com/en/products/floors/](http://www.tatasteelconstruction.com/en/products/floors/)

[www.tatasteelconstruction.com/en/reference/publications/envelope/](http://www.tatasteelconstruction.com/en/reference/publications/envelope/)

[www.tatasteelconstruction.com/en/reference/publications/structural\\_steel/corrosion/](http://www.tatasteelconstruction.com/en/reference/publications/structural_steel/corrosion/)

[www.tatasteelconstruction.com/en/reference/publications/structural\\_steel/advance/](http://www.tatasteelconstruction.com/en/reference/publications/structural_steel/advance/)

[www.tatasteelconstruction.com/en/reference/publications/structural\\_steel/tubes/](http://www.tatasteelconstruction.com/en/reference/publications/structural_steel/tubes/)

All SCI resources are available via [www.steelbiz.org](http://www.steelbiz.org)

Guidance on the design and construction of steel framed buildings is available at [www.steelconstruction.info](http://www.steelconstruction.info)

# 2 SUBMISSIONS

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## 2.1 SUBMISSION CONTENT

The submission is to be a single copy of the report, calculations and drawings, for which you have been commissioned (see Section 1.2) and should not exceed a total length of 70 single sided A4 pages plus two drawings.

The submission should include the following:

### a) Report

A **maximum** of 35 pages of double spaced text, either printed with a minimum font size of 11 pt or neatly hand written, to include:

- i) A description of the structural arrangements for the structure, including in particular the means of transferring lateral loads to the foundations;
- ii) An outline of the design process, which led to the development of the final scheme;
- iii) A demonstration that the sway sensitivity of the structure has been assessed, and accounted for if necessary;
- iv) A demonstration that the dynamic behaviour of the structure has been considered;
- v) A brief description of the proposed methods of construction should be given. These need not be quantified or described in detail but they must be feasible; the problems that might be encountered during construction should be discussed, together with the steps that might be taken to overcome them;
- vi) Detail design of the primary members. Typical connections should be shown;
- vii) A schedule of foundation loads;
- viii) An artist's impression, sketch or image (which may be freely used by the sponsors), which conveys the essence of the recommended scheme. The graphic must be A3 and must not disclose the identity of the competitor.
- ix) In addition to the graphic described in viii), entries must include a JPEG image of the structure, on a CD, which the competition sponsors may freely use in any way whatsoever.

### b) Calculations

A **maximum** of 35 pages of calculations, which must include detailed calculations to confirm the adequacy of the main steel members proposed. This should include the detailed design of typical connections.

### c) Drawings

Two A1 drawings. The drawings must indicate all relevant dimensions, and must show:

**Drawing 1** Plans, elevations and cross sections of the proposed structure, at appropriate scales. It should show relevant member forms and sizes, and give general specification clauses covering material, workmanship, corrosion protection, etc.



**Drawing 2** Typical details e.g. connections, cladding and glazing interfaces (if any), at an appropriate scale.

**d) Other submission requirements**

- i) All calculations must be submitted on sheets in the format of the calculation sheet shown on page 10. A calculation sheet may be downloaded from the discussion area of the SCI's web site at: <http://discus.steel-sci.org>
- ii) If a computer analysis is used, then the main members should be checked by hand calculations and these calculations must be submitted with the report. Where appropriate, computer input and summary results for the final run should be included.
- iii) Computer drawings using a CAD system are acceptable.
- iv) No sheets or drawings of any entry should contain the identity of the competitor or of the university represented. Total anonymity must be maintained in all submissions.
- v) Note the requirements for an A3 graphic, and CD, both as described in Section 3.1(a) viii and ix.

## **2.2 SUBMISSIONS AT THE UNIVERSITY**

All students intending to submit an entry for this competition should inform the academic tutor in charge of the project at their university, who should submit a Notice of Intent form (page 12) by **Friday 24 January 2014**.

Completed submissions should be handed to the tutor in sufficient time to allow for the selection of the best entry from the university.

## **2.3 SENDING SUBMISSIONS TO THE SCI**

The chosen submission from each university must be received at the SCI by **4:00 pm on Tuesday 17 June 2014**. Late submissions will not be accepted.

# 3 CRITERIA FOR JUDGING

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## 3.1 LOCAL

The competition will operate at two levels. The academic tutor(s) involved with the project at that university will first judge all submissions made at each university locally. The winning submission at each university will then be entered for the national competition. A certificate will be issued to all those reaching the national final.

Only one entry from each university will be considered to go forward for final judging at national level.

## 3.2 NATIONAL

All winning local submissions will be judged at national level using the following criteria:

- (a) The exploration of alternative structural forms and the discussion leading to the selection of the chosen scheme.
- (b) The discussion leading to the chosen scheme.
- (c) The stability, structural integrity and aesthetics of the chosen scheme.
- (d) The imaginative and innovative use of structural steelwork.
- (e) The buildability and safe construction sequence of the scheme.
- (f) The clarity and conciseness of the report and the drawings describing the proposed structural schemes.
- (g) Effectiveness in communicating the proposed scheme to the client.
- (h) Compliance with the Brief.

Note that the structural solution will carry a high weighting during judging. Entrants should ensure the structural concept and arrangements are clearly described.

**The interpretation of these criteria by the Judges will be final.**

Marks will be lost for failure to cover all the requirements set out in the brief. No marks will be gained for the inclusion of features not called for in the brief.

# **4 THE AWARDS**

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## **4.1 UNIVERSITY LEVEL**

A certificate will be issued to all those reaching the national final.

## **4.2 NATIONAL LEVEL**

The winners of the competition will receive certificates and prizes up to a total of £2,500. The exact division of the prize money will be decided by the Judges and will depend upon the standard of the submissions received. Generally, the judging panel will seek to award up to three prizes. The winners' universities will also receive certificates.

## **4.3 ELIGIBILITY**

Individual entries, or team entries from a small group of students, will be accepted. Although the competition is aimed at final year students, entries from students at any other appropriate stages will also be considered at the discretion of the course tutors.

No family member of staff from the sponsoring body or the judges, nor any partner, associate or employee from their companies or practices, shall be eligible to enter the competition or to assist a competitor. Assistance is available through the competitions website, <http://discus.steel-sci.org>



## CALCULATION SHEET

Job No.	Sheet	Of	Rev
Job Title			
Subject	Historic Ship Enclosure		
Client	Made by	Date	
	Checked by	Date	

# How to Enter

1. To enter the competition the academic tutor(s) at your university should firstly complete the enclosed **Notice of Intent** form and return it to the competition organiser at the address given below by **Friday 24 January 2014**. This will enable the SCI to provide supplementary information should this be necessary.
2. Any questions that competitors wish to ask should be submitted via the Undergraduate Prize Awards discussions area of the SCI's web site at <http://discus.steel-sci.org>. All competitors should review the questions and responses posted to the site; automatic notification can be set up via the user profile.
3. The completed **Entry Form and Authorship Declaration** (contained in this booklet) should reach the competition organiser at the address given below by **Friday 9 May 2014**. On receipt of this, the SCI will issue each competitor with an entry reference number, which should be marked clearly on all items forming the design entry and on the outside of the package in which the entry is submitted. **No other form of identification or distinguishing mark should appear on any part of the submission.**
4. A successful competitor must be able to satisfy the judges that he or she is the bona fide author of the design that he or she has submitted.
5. Competitors should retain the originals of the designs and drawings submitted. The organisers cannot be held responsible for loss or damage to submissions which may occur either in transit or during exhibition, storage or packing.
6. Design entries must be received by **4.00 pm on Tuesday 17 June 2014**.
7. The designs awarded first, second and third places will be announced in early July 2014 (date to be confirmed).
8. Any entry shall be excluded from the competition if:
  - i) the competitor does not meet the eligibility requirements detailed in Section 4.4;
  - ii) the entry is received after the competition closing date, **4.00 pm on Tuesday 17 June 2014**;
  - iii) the competitor shall in any way disclose his or her identity or that of their university;
  - iv) the competitor attempts to influence either directly or indirectly the decision of the judges;
  - v) in the opinion of the judges, the design does not substantially meet the requirements of the brief.

Only one copy of each competitor's design is to be sent in a single package, carriage paid to:

The Competition Organiser  
Tata Steel / BCSA Student Awards Structural Steel Design  
The Steel Construction Institute  
Silwood Park, Ascot  
Berkshire, SL5 7QN

Tel: 01344 636525  
Fax: 01344 636570



# Notice of Intent

(to be submitted by **Friday 24 January 2014**)

## **TATA STEEL / BCSA STUDENT AWARDS STRUCTURAL STEEL DESIGN: 2013/2014**

*If you wish to enter the competition, the academic tutor(s) at your university should complete this form and return it to the address given below in a sealed envelope.*

Name of academic tutor(s) .....

.....

email(s) .....

Telephone No. ....

University .....

Address .....

.....

.....

.....

This year, we expect approximately ..... students will participate in the competition or use this brief as a design exercise.

.

Signature(s) .....

.....

Please return to:

The Competition Organiser  
Tata Steel / BCSA Student Awards Structural Steel Design  
The Steel Construction Institute  
Silwood Park  
Ascot  
Berkshire  
SL5 7QN

Tel: 01344 636525  
Fax: 01344 636570



# Entry Form and Authorship Declaration

(to be submitted by **Friday 9 May 2014**)

## TATA STEEL / BCSA STUDENT AWARDS STRUCTURAL STEEL DESIGN 2012/2013

*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* **BLOCK CAPITALS PLEASE**

University .....  
Name of academic tutor(s) .....  
Email address(es) .....

The following student(s) have been selected to represent my university in the above competition.

Student's name ..... Year .....  
Tel. no. ....  
email .....  
Home address .....  
.....

Student's name ..... Year .....  
Tel. no. ....  
email .....  
Home address .....  
.....

Student's name ..... Year .....  
Tel. no. ....  
email .....  
Home address .....  
.....

Student's name ..... Year .....  
Tel. no. ....  
email .....  
Home address .....  
.....

1. \*I/We have complied with and accepted the regulations and conditions 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 design.
3. \*I/We declare that the design is \*my/our work and that the drawings have been prepared by \*myself/ourselves.

Signature, student(s) ..... Date .....

Signature, academic tutor(s) ..... Date .....

This form is to be completed by the competitor(s) and the academic tutor(s), placed in a sealed envelope and returned to the address given below. **An entry reference number will then be given, which should be marked clearly on all items forming the design entry and on the outside of the package in which the entry is submitted.**

Please return to: The Competition Organiser  
Tata Steel / BCSA Student Awards Structural Steel  
Design  
The Steel Construction Institute  
Silwood Park, Ascot, Berkshire, SL5 7QN

Tel: 01344 636525  
Fax: 01344 636570



The Steel Construction Institute