A WORLD TOUR OF STRUCTURAL FORM

Student Briefing Pack
Long Version

BRIEFING

The creative process is founded upon building blocks of basic knowledge and skills. One of the important building blocks of creative structural design is an awareness of basic structural form and understanding how these forms transfer simple loads to their supports. With these basic structural forms in mind, the adept designer can quickly sketch up a number of solutions to a structural problem before evaluating which solution should be developed further.

The aim of this workshop is to help you develop your awareness of basic structural forms and their behaviour, and to use this understanding to help you rapidly develop a number of solutions to a structural problem.

This workshop is broken into two halves. In the first part of the Workshop, your task is to examine a number of existing structures and to determine how they respond to horizontal and vertical loads. You are encouraged to use the modeling tools on Expedition Workshed (Push Me Pull Me, Catastrophe and PMPM 3D) to help you explore how these structures behave. In a group discussion you will be asked to identify common structural forms amongst these projects.

For each of these common estructural forms you will find rules of thumb for estimating the appropiate aspect ratio (span to depth) in the Engineer's Toolbox hosted in the tools area of Workshed. Knowing these rules of thumb will help you quickly draw structures that 'look' right.

In the second half you will be presented with a structural problem and asked to quickly propose a number of structural responses to the problem, based on the knowledge that you have developed in the first part.

Part 1 – World tour of structures

For each of the structures illustrated in this document, try to determine how vertical and horizontal forces are transferred to the supports (the support is typically the ground). You can use the modeling tools in Workshed to help you find the answers. For each structure you can also check if it follows the span-to-depth rules of thumb listed in the Engineer's Toolbox.

To conclude this first part, review your answer from part 1 and ask yourself if these structures share any characteristics that would allow you to group them under a small number of categories?

Part 2 – Rapid design

The first part of this workshop is designed to help you build up your basic knowledge of structural form which you can know apply in Part 2. The Workshop facilitator will set you a simple design problem. Your task is to quickly develop three structural responses to this design problem.

Your responses only need to be a quick sketch, but it is important that you draw your structure with realistic proportions. The structures that you have studied in this workshop should be provide a guide on proportions. You may also want to refer to the Engineer's Toolbox (found in the Tools area of Workshed) that contains useful rules of thumb for structural sizing.

TIPS FOR WORKSHED'S MODELING TOOLS

As part of this Workshop you will be introduced to three modeling tools on Workshed: Push Me Pull Me; Catastrophe; and PMPM 3D. These notes are to help you get started with using these tools.

All tools can be found at www.expeditionworkshed.org Please note that as the website is flash-based it is not accessible through Apple mobile devices. All modeling tools require the zoom of the browser to be set at 100%. For further technical support please visit the help and FAQ pages on the Workshed Blog.

Push Me Pull Me

This tool allows you to play with simple structural forms in order for you to see how they respond to points loads. The tool allow you to compare a render of a real structure with the associated line diagram. It also displays bending moment, shear force and axial force diagrams. Push Me Pull Me does not allow you to create your own structures; however, there are lots of models for you to choose from in order to compare with the example projects in this workshop.

Catastrophe

Catastrophe combines a game and modeling tool. In 'play' mode you can see how many structural elements you can remove from famous structures without them falling down. In 'draw and test' you can create your own simple structures, and push and pull them apart.
To create your own structure:

- Click on 'draw and test'
- Select 'nodes' from the menu on the right-hand side
- Use the mouse pointer to place nodes where you want them
- Select 'add bars' from the menu on the right-hand side
- Add bars by selecting the starting node and then the end node for the bar
- Click on 'constraints' to fix a number of the nodes in space
- Click on 'gravity' to switch the model from drawing mode to testing mode.

Note that unlike the Push Me Pull Me models, Catastrophe only allows you to model pin-joined structures.

PMPM 3D

This is the most advanced modeling tool on Workshed. At the time of writing, the tool is still being developed and so the functionality is still limited. PMPM 3D is accessed from the Models area in Workshed. When loading any of the PMPM 3D models you will be asked whether you want to block unsafe content. Click 'no' in order not to block this content (for more information on why it is ok to load unsafe content, see the FAQ page on the Workshed blog).

Using the models in PMPM3D you can push and pull structures in 3D. Note that the structures built using PMPM 3D can contain both fixed and pinned connections. For more information follow the specific instructions under the 'INFO' section for each model on the website.

EIFFEL TOWER - PARIS

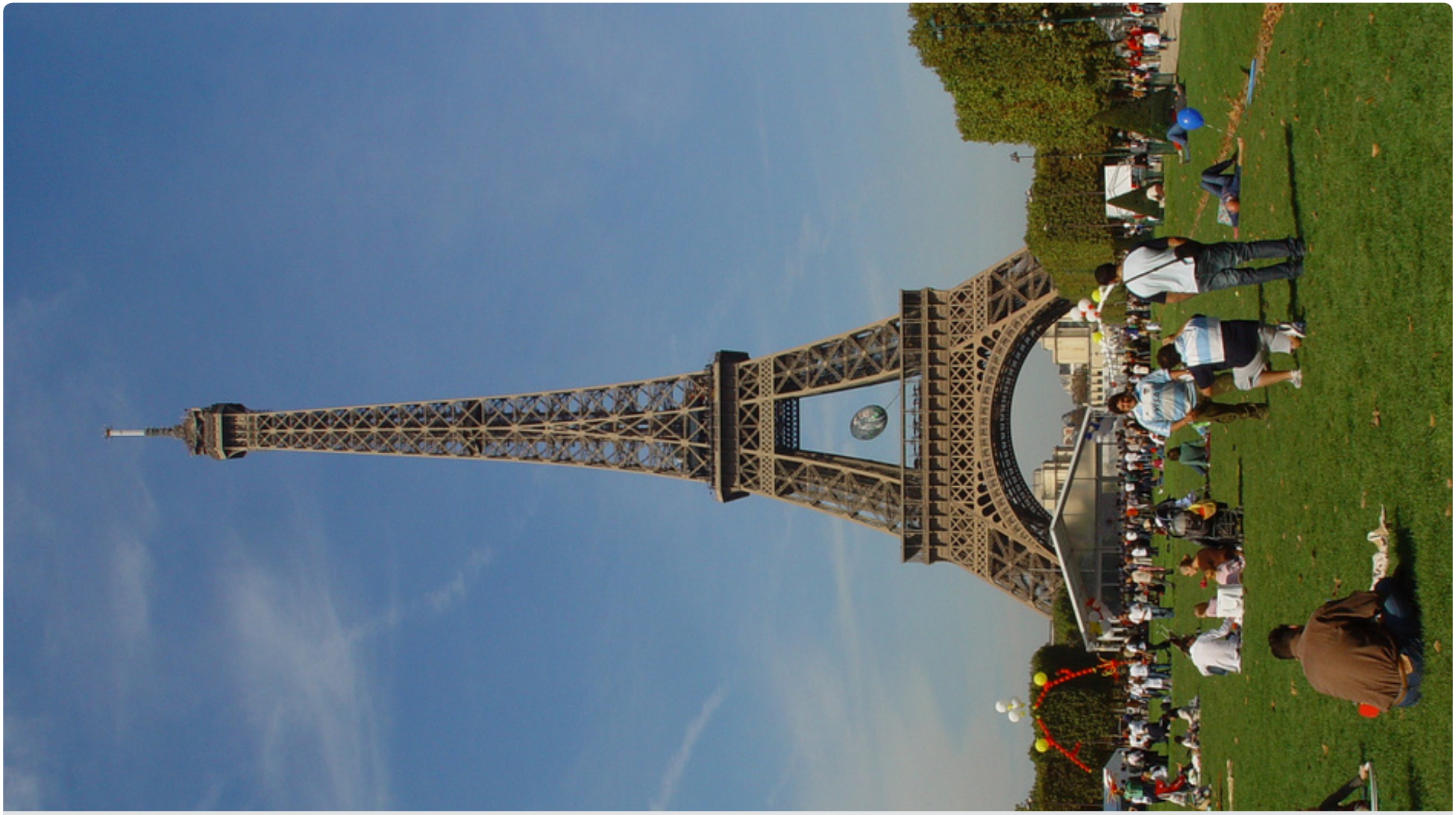

Photo by Flickr user *Tilemahos_E*

PONT DE NORMANDIE - FRANCE

Photo by Francois Roche

FORTH RAIL BRIDGE - EDINBURGH

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BURJ AL ARAB - DUBAI

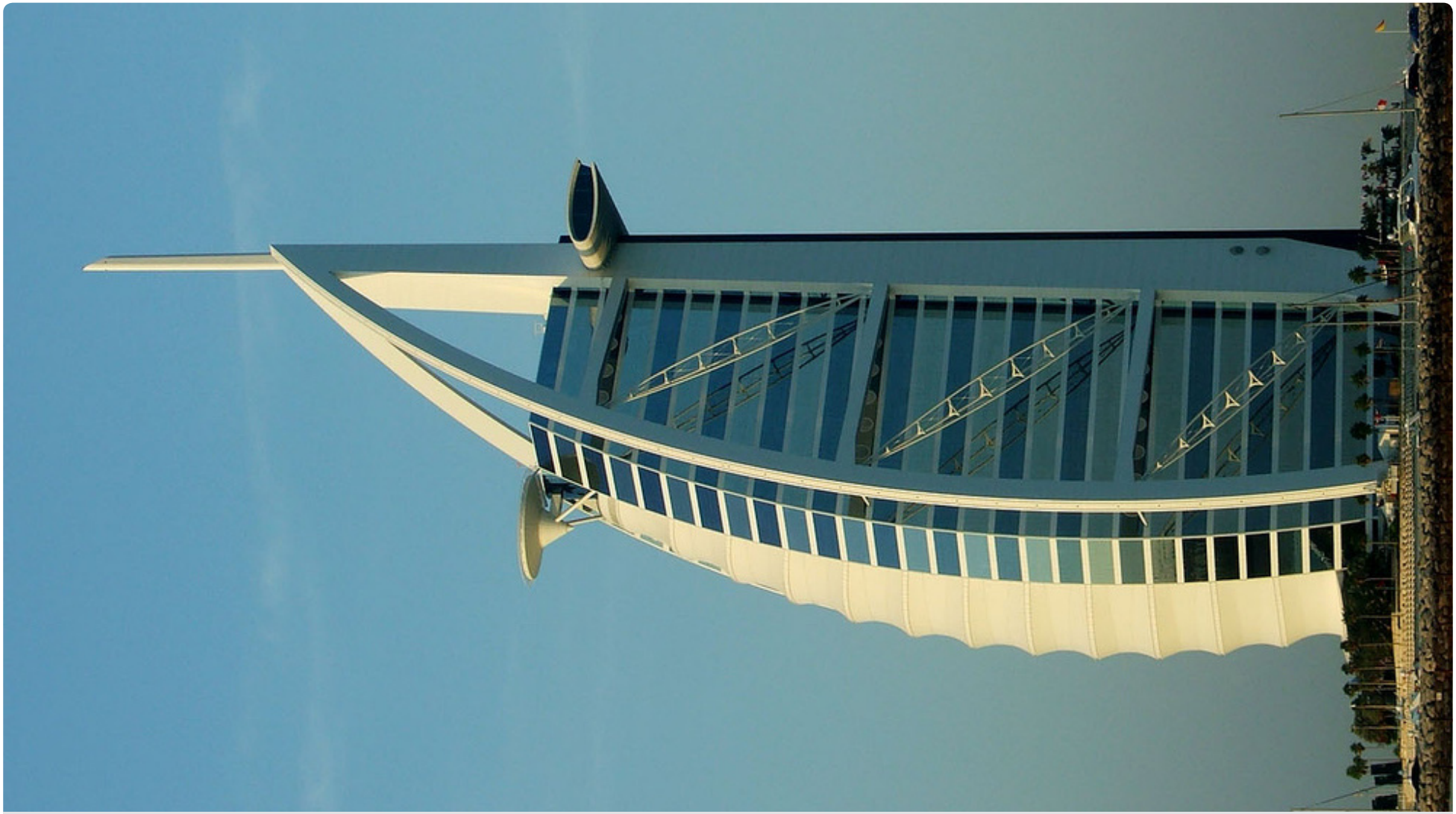

Photo by Nitin Badhwar

ÎLE DE RÉ BRIDGE - FRANCE

Photo by Nitin Eole Wind

AQUATICS CENTRE - LONDON

Photo from www.archivias.com

BURJ KHALIFA - DUBAI

Photo by Michael Pfeiffer

HOOVER DAM BYPASS BRIDGE - NEVADA*

* The full name of the bridge is actually the Mike O'Callaghan – Pat Tillman Memorial Bridge. Photo by Steve Parker

HSBC MAIN BUILDING - HONG KONG

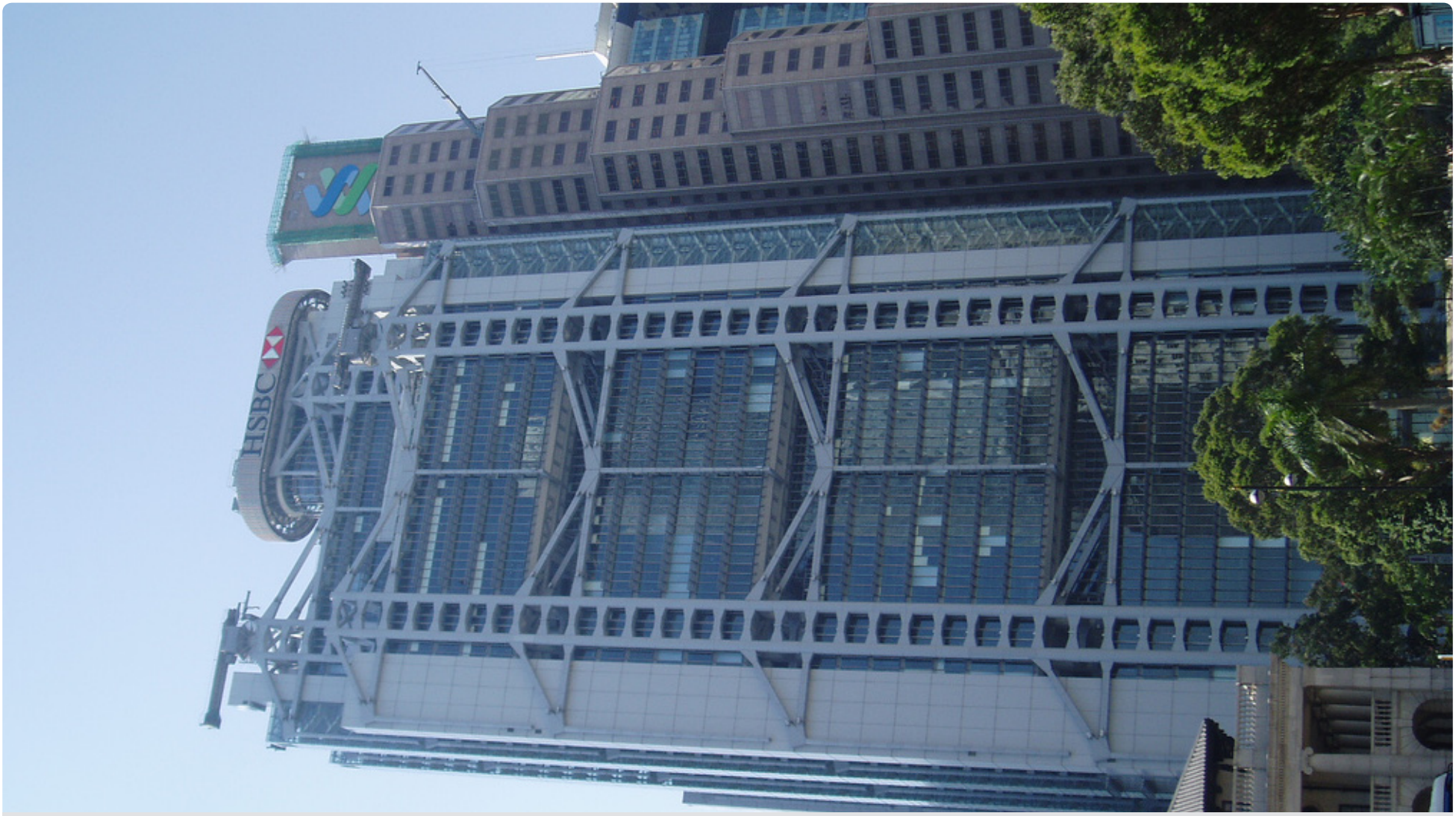

Photo by Steve Cadman

JOHN HANCOCK CENTRE - CHICAGO

Photo by Bosc d'Anjou

INFINITY BRIDGE - STOCKTON-ON-TEES

Photo by Morley Von Sternberg for Expedition

MAIDENHEAD RAILWAY BRIDGE - ENGLAND

Photo by Keith W. Day

SPACE NEEDLE - SEATTLE

Photo by Doug Kerr

ROYAL ALBERT BRIDGE - SALTASH

Photo by Graham Richardson

STONEHENGE - WILTSHIRE

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SYDNEY HARBOUR BRIDGE - AUSTRALIA

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EMIRATES AIR LINE - LONDON

Photo courtesy of Expedition

TORRE DE COLLSEROLA - BARCELONA

Photo by Emily Allen

BURRARD BRIDGE - VANCOUVER

Photo by Kenny Louie

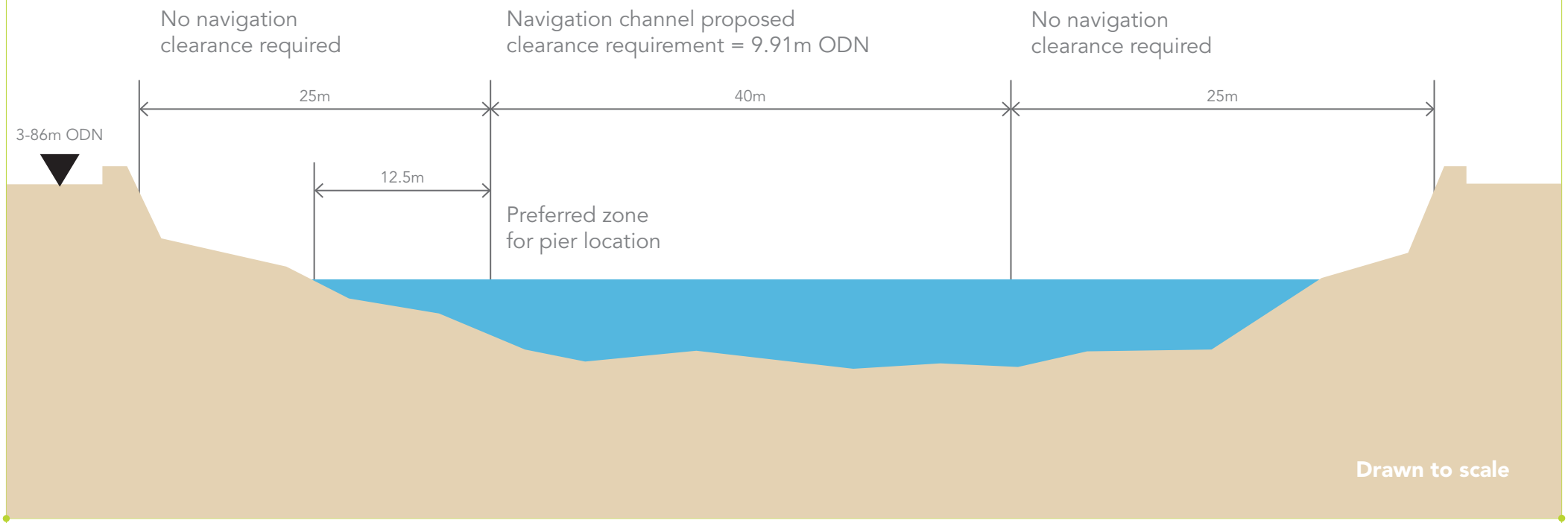
VELODROME - LONDON

Photo by Steve Bates for Expedition

DESIGN CHALLENGE

In this part of the Workshop, you are required to design a structure. The workshop faciliator will give you details of the brief.

Key dimensions are given below. You will be required to produce three options, which you can sketch using the following pages. You may consider using the tools on Workshed to help you model your design proposals.



OPTION 1

OPTION 2

OPTION 3

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