Tectonics 1 – An Introduction to Materials, Structure & Construction
23CVA057

Semester 2 2024 Online Short-window Exam paper

This is an online short-window examination, meaning you have a total of **2 hours plus an additional 30 minutes** to complete and submit this paper. The additional 30 minutes are for downloading the paper and uploading your answers when you have finished. If you have extra time or rest breaks as part of a Reasonable Adjustment, you will have further additional time as indicated on your exam timetable.

It is your responsibility to submit your work by the deadline for this examination. You must make sure you leave yourself enough time to do so.

It is also your responsibility to check that you have submitted the correct file.

Exam Help
If you are experiencing difficulties in accessing or uploading files during the exam period, you should contact the Exam Helpline. For urgent queries please call **01509 222900**.

For other queries email examhelp@lboro.ac.uk

You may handwrite and/or word process your answers, as you see fit.

Answer **THREE** questions.

All questions carry equal marks.

Continues/…

…/continued

1. Figures Q1a, b and c show the construction sequence and other aspects of the Delta Shelter, built in Mazama, Washington in 2005, designed by Olson Kundig. Consider these figures carefully and answer the questions below:

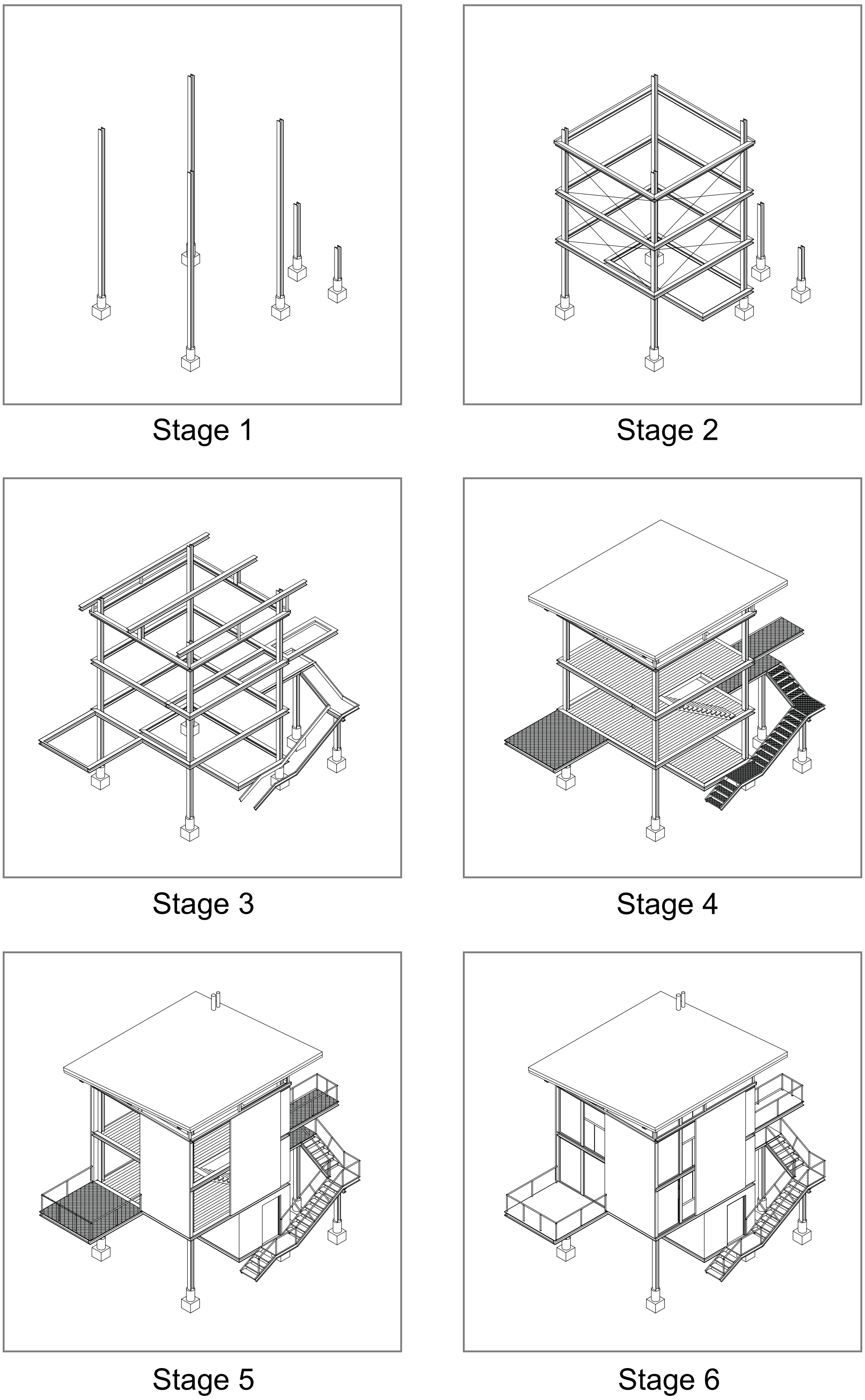

Figure Q1a: Construction sequence of the Delta shelter.

Question 1 continues/…

…/question 1 continued

Figure Q1b: Delta shelter construction.

Figure Q1c: Delta shelter over winter.

Question 1 continues/…

…/question 1 continued

Figure Q1d: Delta shelter exterior cladding.

Figure Q1e: Delta shelter construction.

Question 1 continues/…

a) Considering all the Figures, what were the main construction challenges faced during the building construction process of the Delta shelter? Explain your reasoning.

[4 marks]

b) How did the use of prefabrication contribute to the efficiency and speed of constructing the Delta shelter, and why was this important?

[3 marks]

c) Based on Stage 1, Figure Q1a, describe the foundation system employed for the Delta shelter and explain why this type of foundation was chosen.

[4 marks]

d) Considering Figure Q1c, d and e, what materials were used in the construction of the Delta shelter, and why was the exterior cladding selected to withstand extreme weather conditions? Explain your reasoning.

[4 marks]

e) Considering Figure Q1b, what temporary structural elements had to be included as part of the structure to ensure lateral stability, explain your reasoning.

[4 marks]

f) How did the building elevation with its steel stilts and the implementation of large steel shutters contribute to the construction and functionality of the Delta shelter? Explain your reasoning.

[4 marks]

g) Over Figure Q1b, draw with red colour the primary structural elements and with blue colour the secondary structural elements.

[3 marks]

h) Considering that Mazama winter snowfall can be up to ten feet, what considerations had to be taken on the structural design of the Delta shelter, to ensure it can withstand the additional extra weight. Refer to Figure Q1e.

[3 marks]

i) The Delta shelter has a squared floor plan, with three balconies in total. As seen in Figure Q1c, it has two balconies towards the right side, and one balcony towards the left side. Considering that the external staircase is an independent structure. What condition had to be considered regarding the size of the balconies to ensure that the overall structure is in equilibrium? Explain your reasoning with a floor plan diagram.

[4 marks]

Continues/…

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2. Figures Q2a, b and c show the construction sequence and other aspects of the Castelar building, built in Madrid in 1983, designed by Rafael de La-Hoz. Consider these figures carefully and answer the questions below:

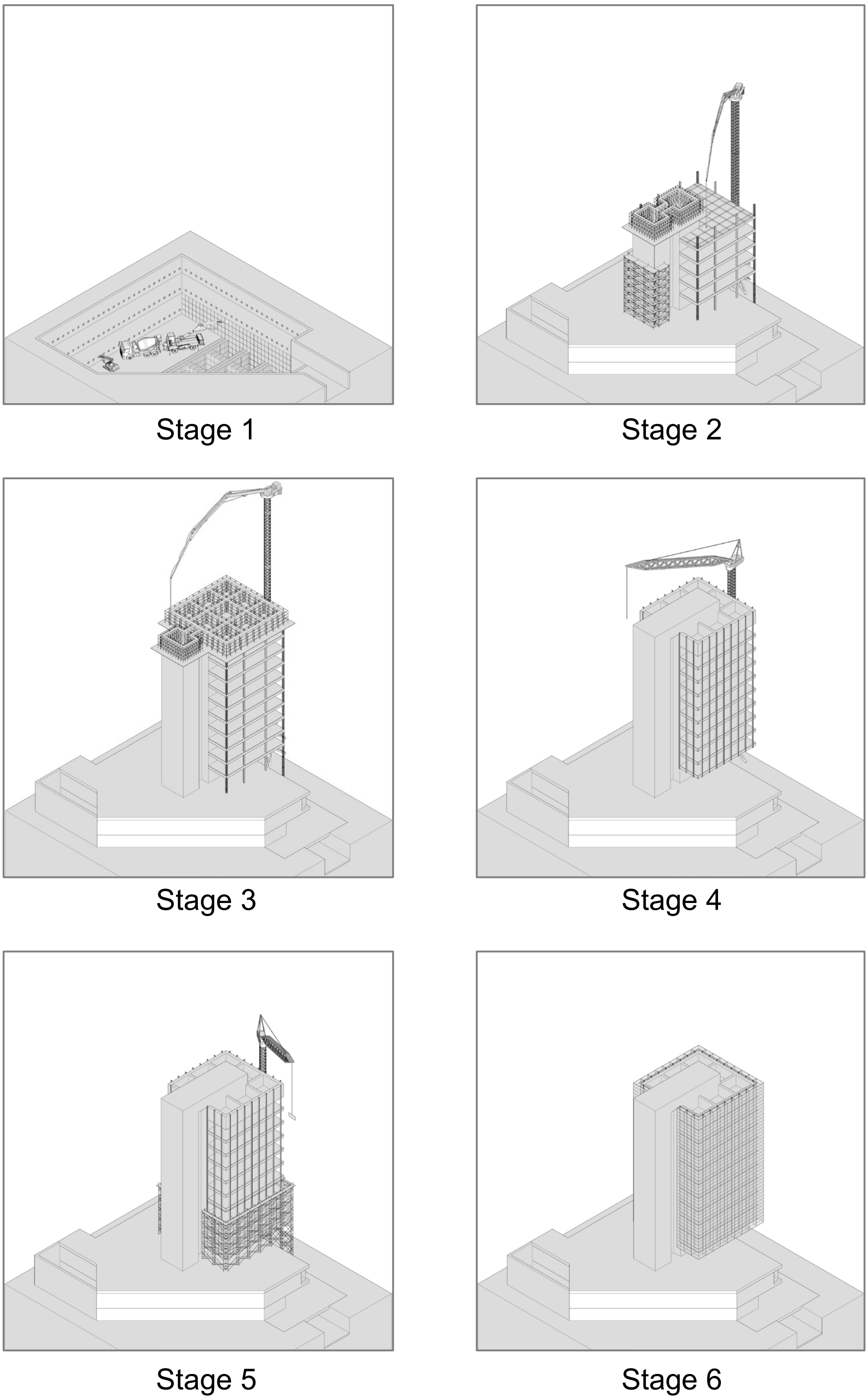

Figure Q2a: Construction sequence of the Castelar building.

Question 2 continues/…

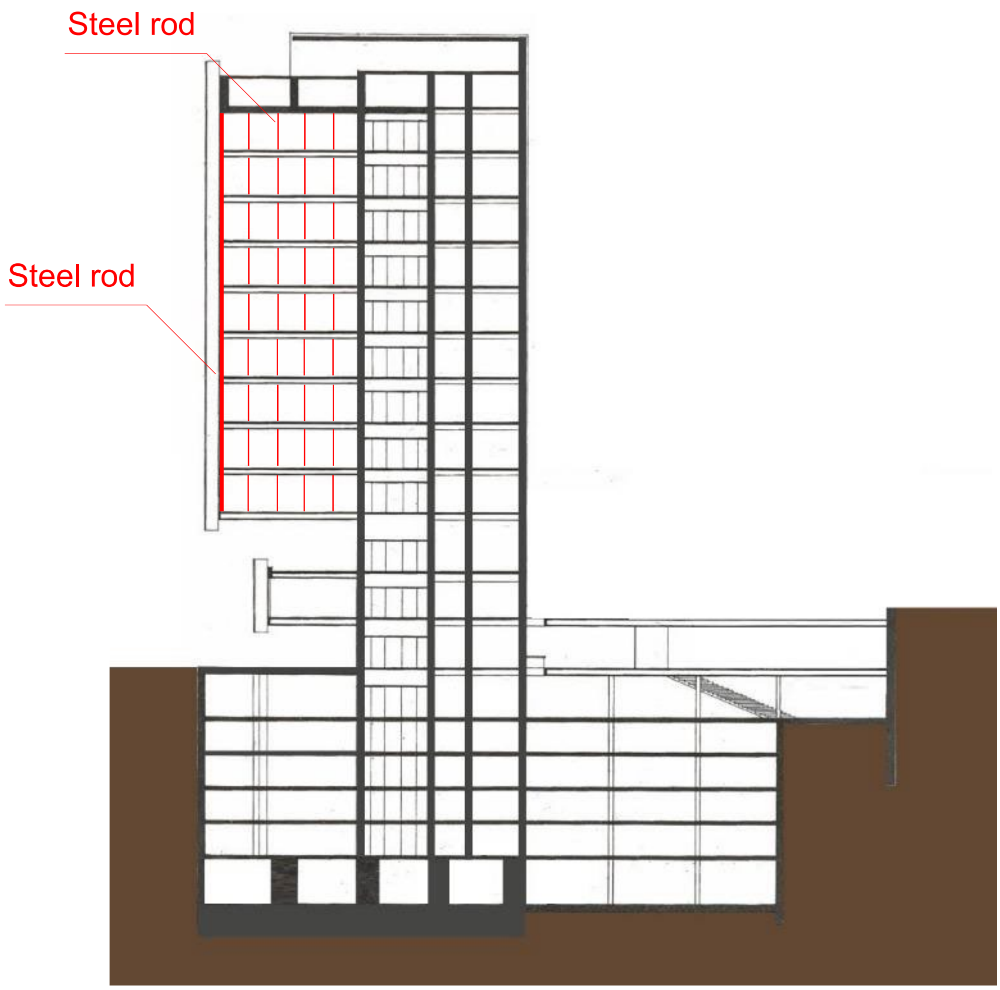

Figure Q2b: Cross-section Castelar building.

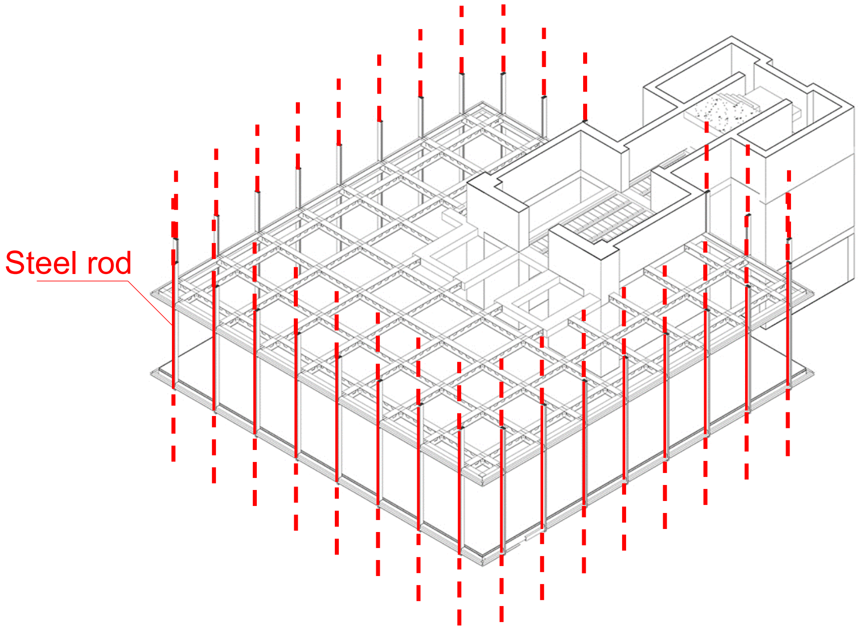

Figure Q2c: Isometric diagram showing the steel rods in the colour red.

Question 2 continues/…

…/question 2 continued

a) From a structural analysis point of view, what type of axial forces are the steel rods of the façade experiencing? Explain your reasoning.

[4 marks]

b) Figure Q2b and Figure Q2c show thirty steel rods hanging as part of the façade, which are being held by the concrete roof structure. Explain why steel is used for the rods rather than non-ferrous metals or iron.

[4 marks]

c) Considering Stage 2, Figure Q2a: why do you think the central tower of the building was built with concrete cast on-site? Explain your reasoning.

[4 marks]

d) If the mixture of concrete used for this building is made up of 3 tonnes of cement and 1200 litres of water, what is the water/cement ratio, and what kind of concrete would this result in?

[3 marks]

e) Describe what measures should have been taken for the proper drainage of rainwater accumulation on the concrete roof as seen in Stage 6, Figure Q2a.

[4 marks]

f) Considering Stage 1, Figure Q2a: explain what has been completed at this stage, and what measures have been taken to prevent the sides of excavations from collapsing.

[4 marks]

g) In Figure Q2c, the typical floor plate structure was constructed using steel castellated beams. Please provide the name of this type of floor slab and one reason for its use from the point of view of Structural analysis.

[4 marks]

h) Considering Stage 5 in Figure Q2a, and Figure Q2c: explain how the floor slabs are supported.

[3 marks]

i) Draw a loadpath diagram for only the tower of the Castelar building, over the cross-section shown in Figure Q2b. Use a key with red arrows for the load vectors and black arrows for the applied vertical loads.

[3 marks]

Continues/…

…/continued

3. Figures Q3a, b and c show the construction sequence and other aspects of the Kivik pavilion, built in Österlen, Sweden in 2008, designed by David Chipperfield and Antony Gormley. Consider these figures carefully and answer the questions below:

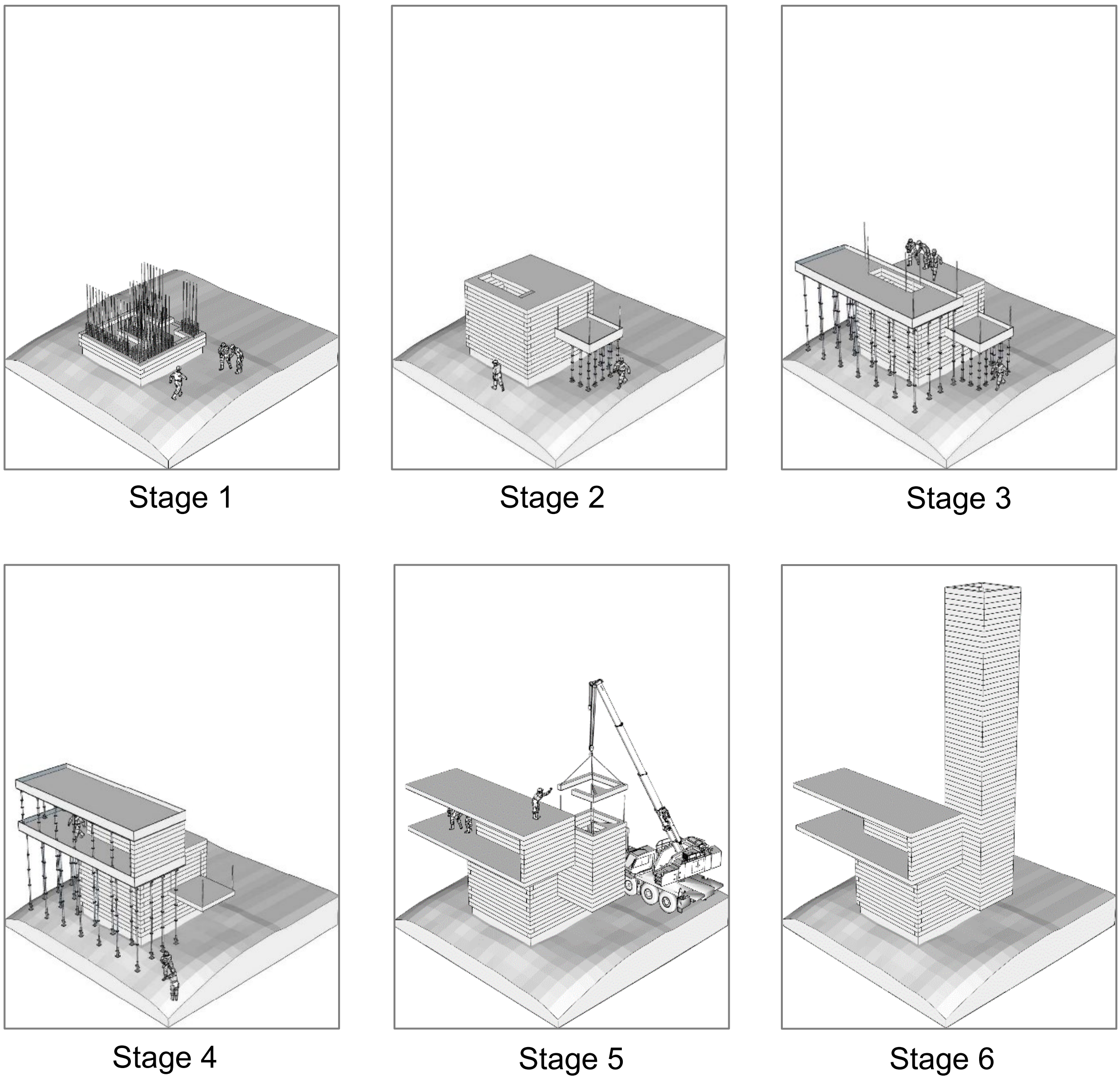

Figure Q3a: Construction sequence of the Kivik pavilion.

Question 3 continues/…

…/question 3 continued

Figure Q3b: Kivik pavilion foundation construction.

Figure Q3c: Kivik pavilion wall blocks.

Question 3 continues/…

…/question 3 continued

Figure Q3d: Kivik pavilion exterior view.

Figure Q3e: Kivik pavilion interior staircase-tower view.

Question 3 continues/…

Figure Q3f: Kivik pavilion exterior corner view.

a) The Kivik pavilion consists of three volumes interlocked through a central volume. Explain what (structural loading) condition had to be fulfilled by the two cantilevered volumes, to ensure that the overall structure is in equilibrium.

[4 marks]

b) Considering Figures Q3a and d, what were the main construction challenges faced during the building construction process of the Kivik pavilion? Explain your reasoning.

[4 marks]

c) Considering Figures Q3a, b and c, explain what type of concrete construction this is, [cast on site, precast, or hybrid], and explain the advantages of making this construction in that way.

[4 marks]

d) Looking at Figure Q3d and e, answer what are the three main risks for the users of the Kivik pavilion?

[3 marks]

e) If the mixture of concrete used for this building is made up of 5 tonnes of cement and 2000 litres of water, what is the water/cement ratio, and what kind of concrete this would result in?

[3 marks]

f) Which other sustainable building construction material could have been used for the construction of the Kivik pavilion, following the same logic of stacked blocks? Explain your reasoning.

[4 marks]

Question 3 continues/…

…/question 3 continued

g) Assess if any measures have been taken for the proper drainage of rainwater accumulation on the concrete flat roofs. Justify your answer.

[4 marks]

h) Over Figure Q2f, draw a vertical line in colour red to indicate the highest vertical path of loading/stress of the Kivik pavilion from the point of view of Structural analysis. Explain your reasoning.

[3 marks]

i) The Kivik pavilion is constructed using three volumes, with each volume having a volume of 100 cubic meters. The total weight of the Kivik pavilion is 600 tonnes of concrete. Can we assume that each individual volume weighs 200 tonnes of concrete? Explain your answer.

[4 marks]

4. Based on the Laboratory visits to the Frank Gibb Lab carried out in Semester 1 weeks 12 or 13, answer the following questions:

a) Explain what C30 means for concrete.

[3 marks]

b) What percentage of the final strength would have been acquired by the concrete sample after 3 days of curing?

[3 marks]

c) What percentage of the final strength would have been acquired by the concrete sample after 7 days of curing?

[3 marks]

d) What percentage of the final strength would have been acquired by the concrete sample after 14 days of curing?

[3 marks]

e) What percentage of the final strength would have been acquired by the concrete sample after 28 days of curing?

[3 marks]

f) Draw a diagram representing the visible failure of a c30 concrete block sample.

[3 marks]

g) Draw a diagram representing the visible failure of a c100 concrete block sample.

[3 marks]

h) Describe the behaviour of the timber beam during the flexure test.

[3 marks]

Question 4 continues/…

i) Describe the behaviour of the steel beam during the flexure test.

[3 marks]

j) Describe the behaviour of the reinforced concrete beam during the flexure test.

[3 marks]

k) Describe the behaviour of the bamboo beam during the flexure test.

[3 marks]

M Mejia-Tamariz