

## Specialist Diploma: Seismic Design

Thursday 4 January 2018

Timetable: 09.30 – 13.00

### Notes to Candidates

1. TO PASS THE EXAMINATION, CANDIDATES MUST SATISFY THE EXAMINERS IN BOTH PARTS OF THE QUESTION.
2. Examiners will only mark work written by hand during the examination. Candidates will not be allowed to include any previously prepared calculations, notes, sketches, diagrams, computer output or other similar material in their answer sheets. Any previously prepared information submitted by candidates will be ignored by the examiners.
3. A fair proportion of marks will be awarded for the demonstration of an understanding of fundamental engineering concepts, as distinct from calculation of member forces and sizes. 60 marks are allocated to Section 1 and 40 marks to Section 2.
4. The Examiners are looking for sound structural designs. It should also be remembered that aesthetics, economy and function are important in any competent engineering scheme.
5. Any assumptions made and the design data and criteria adopted must be stated.
6. Good clear sketches are required; they should show all salient and structural features and should incorporate adequate details.
7. Candidates may not bring into the examination room any electronic devices capable of wireless communication, optical photography or scanning.

The following devices are not permitted: Mobile phones, Laptops, notebooks or portable computers and similar devices, iPads, tablets and similar devices, E-readers (e.g. Kindle) and similar devices, cameras, optical scanners and similar devices.

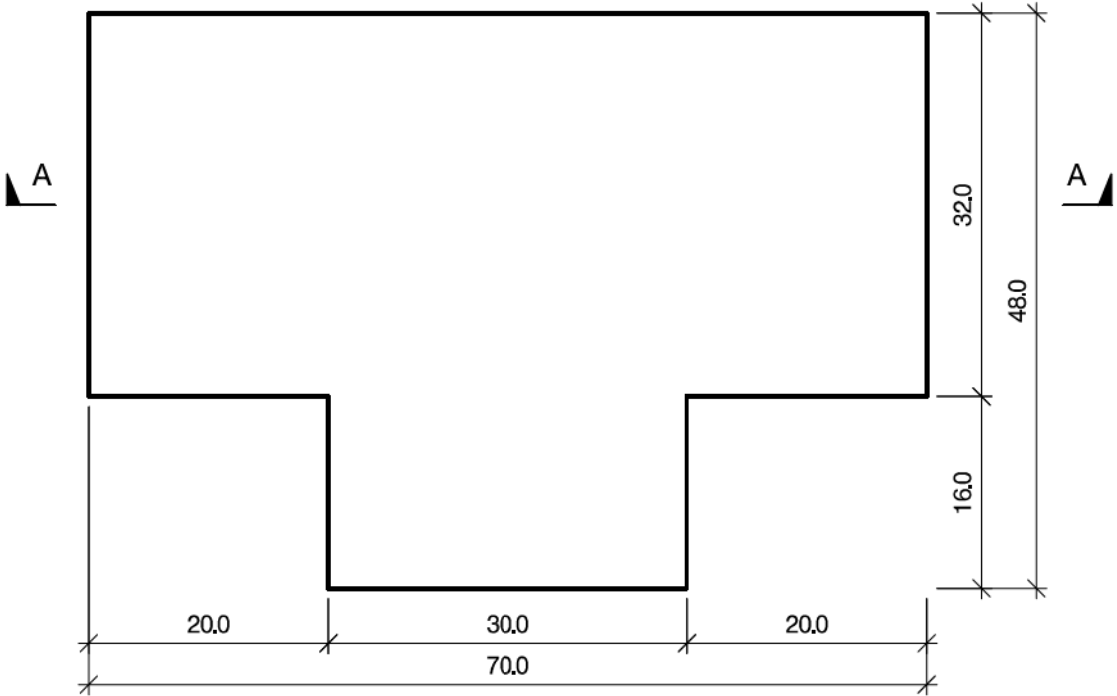
Any candidates arriving at the examination room with such devices will be asked to switch them off and place them in a sealed bag kept by the Invigilator for the duration of the exam.

8. This paper is set in SI Units.
9. Candidates should note that Figures are produced to illustrate the question and are not necessarily drawn to scale. Figured dimensions should be followed.

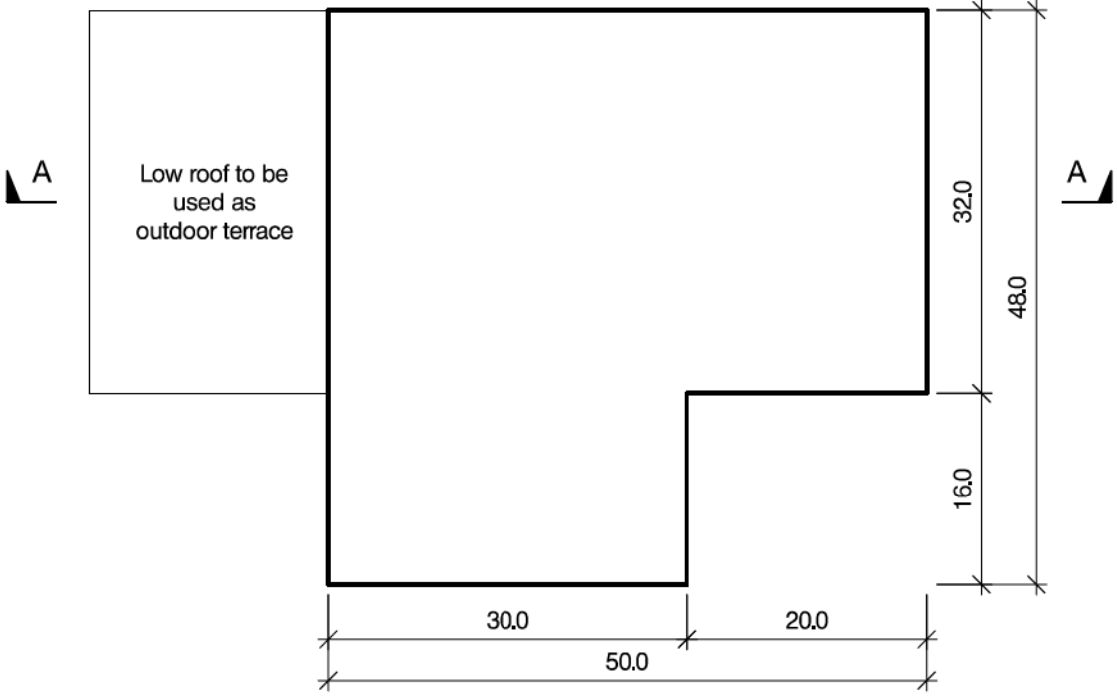


## A reminder on codes of practice

Any design code or standard may be used to answer the question in the paper, as long as reference to that code is consistent throughout and any assumptions made or design data adopted (including loadings other than those specified in the question) are stated at the beginning of the answer.



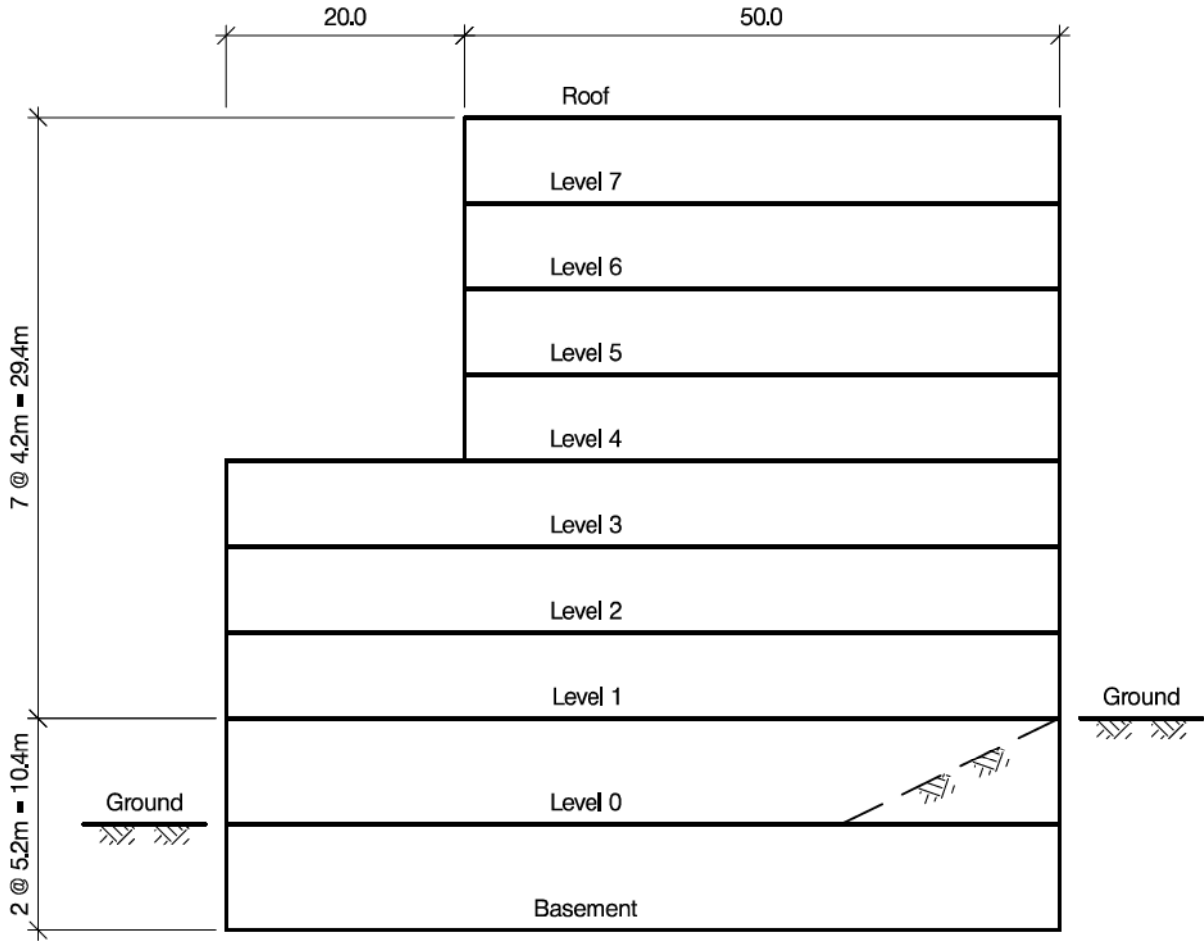
PLAN ON LEVEL 0



PLAN ON LEVEL 4

NOTE: All dimensions are in metres

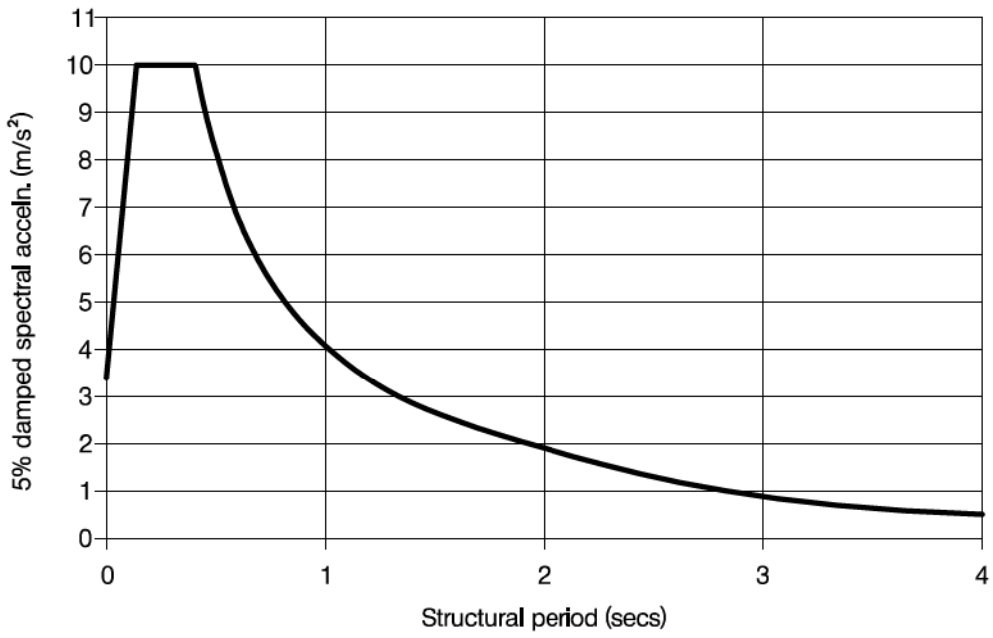
FIGURE 1 Sheet 1



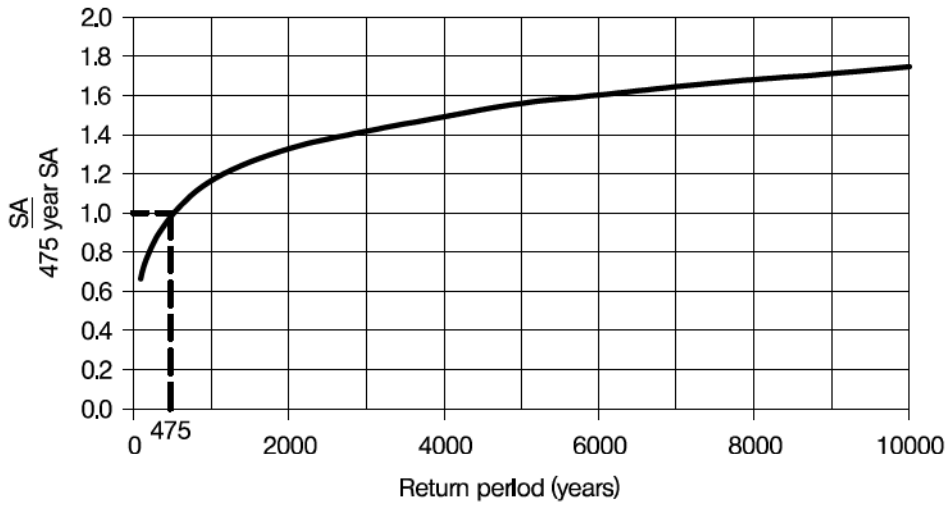
SECTION A - A

NOTE: All dimensions are in metres

FIGURE 1 Sheet 2



**FIGURE 2 :** 475 year return period motions for rock outcrop at site



**FIGURE 3 :** Variation of spectral acceleration SA with return period

# An 8-storey HQ building in a town with high seismicity

## Client's Requirements

1. A new 8-storey building with a basement floor is required as the headquarters for a bank, in a town in an area of high seismicity, see Figure 1.
2. The building is T-shaped in plan and has a setback at level 4 and above: see Fig. 1. All elevations must be 70% glazed.
3. The roofs are flat and the roof at level 4 is to be usable as an outdoor terrace.
4. Column spacing shall not be less than 8.0m throughout.
5. A maximum of two service cores measuring 6.0m x 6.0m in plan can be included at each floor.
6. No bracing nor shear wall is allowed internally except around service cores.
7. All floors have an overall height of 4.2m except for Level 0 and the basement which are 5.2m high. A structural zone of 0.85m is required at each floor.

## Imposed loading

8. Terrace roof: 2.0 kN/m<sup>2</sup>  
 Other roofs: 1.0 kN/m<sup>2</sup>  
 Ground floor: 5.0 kN/m<sup>2</sup>  
 Other floors: 3.0 kN/m<sup>2</sup>+1.0 kN/m<sup>2</sup> allowance for partitions

## Site conditions

9. The site basic wind speed is 46 m/s based on a 3-second gust; the equivalent mean hourly wind speed is 23 m/s.
10. Ground conditions:
 

0 -1.0m	Made Ground
1.0m-4.0m	Soft sand, N=10
Below 4.0m	Dense sand, N=60 (shear wave velocity= 500m/s)
Ground water was encountered at 8.0m below ground level	
11. Figs 2 and 3 show the design 5% damped seismic response spectrum for the region. It applies to level ground with a 475-years return period assuming the ground surface is rock with shear wave velocity of not less than 800m/s.

## Section 1

(60 Marks)

- a. Prepare a design appraisal with appropriate sketches indicating two distinct and viable solutions for the proposed structure. Indicate clearly the functional framing and the structure's method of load transfer and stability aspects for each proposed scheme. Recommend one solution, to be further developed in Section 2.

## Section 2

(40 Marks)

- b. Carry out design checks on key members and connections of the lateral-load-resisting system including a beam-column connection, details of bracing or shear walls, and foundations for the proposed scheme. (30 marks)
- c. If the minimum column spacing for internal columns at level 1 is doubled to give larger column-free areas, discuss the impacts on the scheme. (10 marks)

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