

# Specialist Diploma: Seismic Design

Monday 6 January 2020

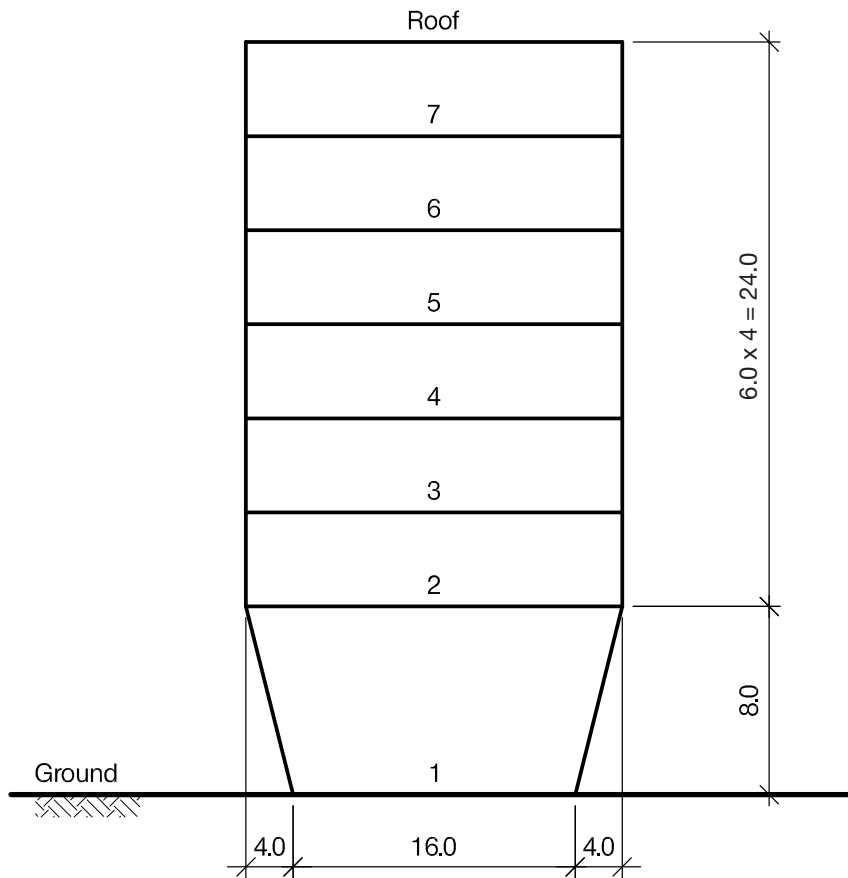
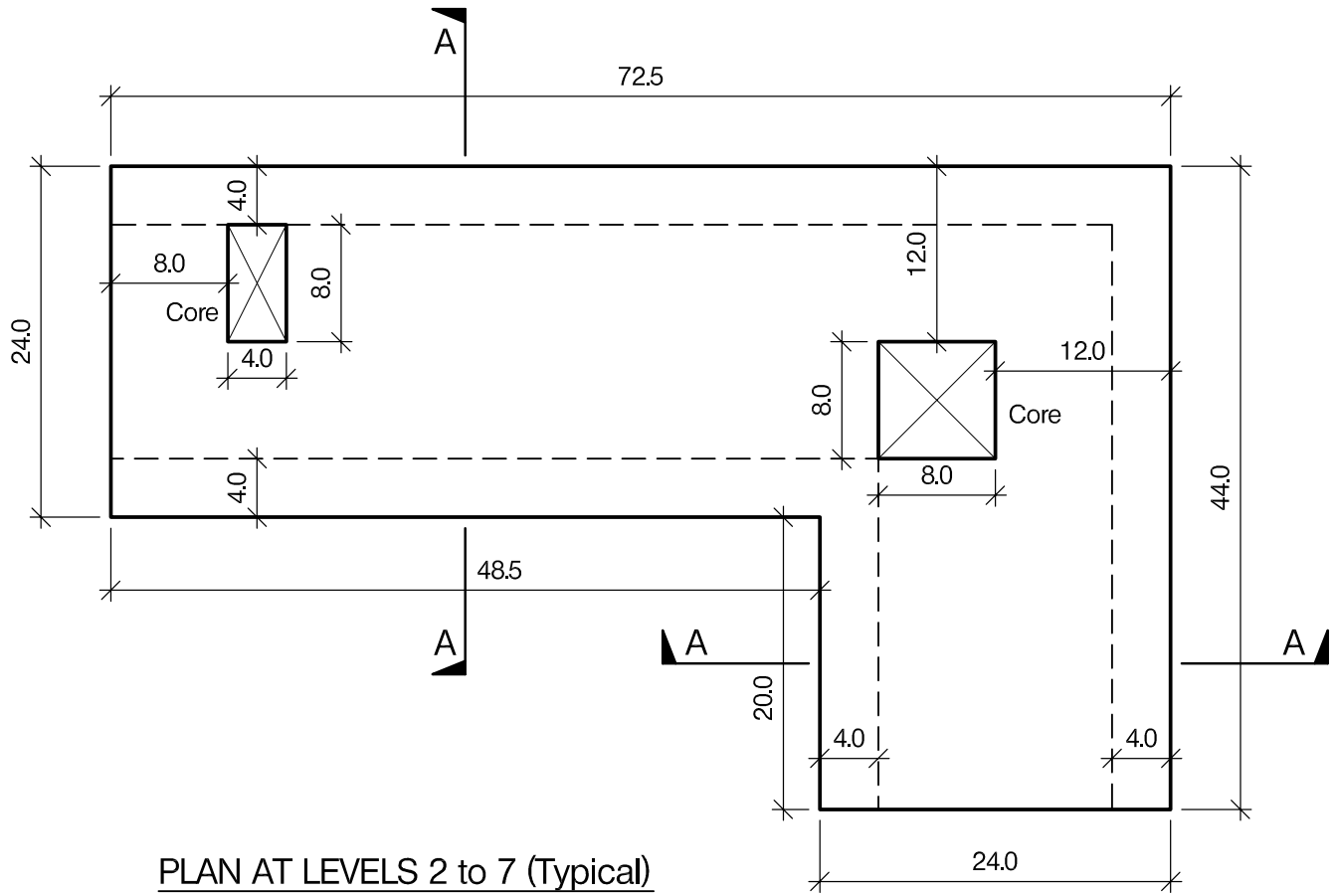
## Notes to Candidates

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. NOTE: In the calculation part, establishing “form and size” is taken to mean compliance with all relevant design criteria, i.e. bending, shear, deflection, etc.
4. 60 marks are allocated to Section 1 and 40 marks to Section 2.
5. 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.
6. Any assumptions made and the design data and criteria adopted must be stated.
7. Good clear sketches are required; they should show all salient and structural features and should incorporate adequate details.
8. 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.
9. This paper is set in SI Units.
10. Candidates should note that Figures are produced to illustrate the question and are not necessarily drawn to scale. Figured dimensions should be followed.



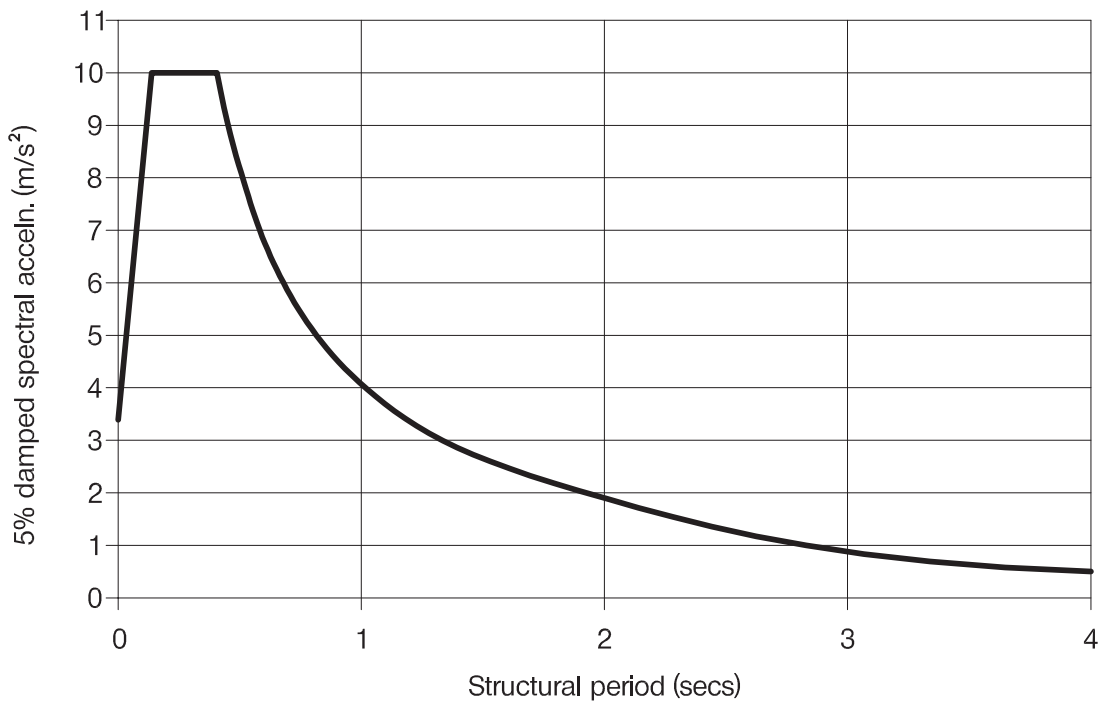
## A reminder on codes of practice

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.

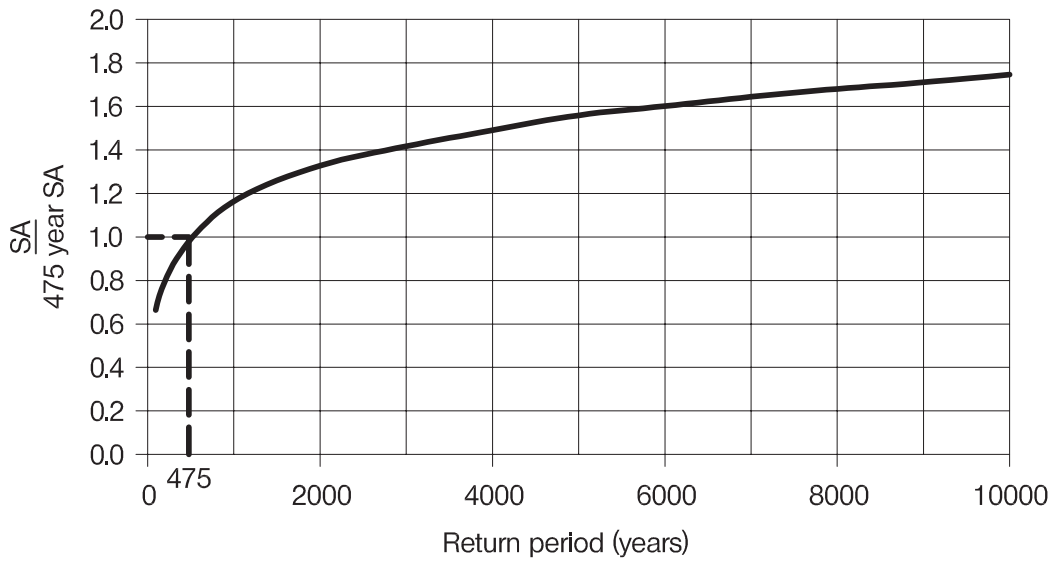


NOTE: All dimensions are in metres

FIGURE 1



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



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

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# 7-storey seismic monitoring headquarters building in a seismic zone

## Client's requirements

1. A new 7-storey seismic monitoring headquarters building is to be built in a town located in a high seismic zone, see Figure 1. The building usage is for monitoring seismic and volcanic activities by operating an earthquake observation network and issuing warnings to mitigate damage caused by earthquakes.
2. The building is of an L-shape form in plan. Level 1 is set back along both longitudinal elevations by 4.0m with inclined facades between level 1 and level 2, see Figure 1. All heavy plant items are located on Level 1.
3. The roof is flat and all elevations are fully glazed.
4. Service cores containing lifts, stairs, risers and services are located as indicated in Figure 1.
5. Column spacing shall not be less than 8.0m throughout. This does not include distance to core walls.
6. No bracings or shear walls are allowed anywhere except in core walls.
7. All levels have an overall height of 4.0m except for Level 1 which is 8.0m high. The clear height required for Level 1 is 5.5m and 2.7m for other levels.

## Imposed loading

- |          |                       |
|----------|-----------------------|
| 8. Roof: | 1.0 kN/m <sup>2</sup> |
| Floors:  | 5.0 kN/m <sup>2</sup> |
| Plant:   | 7.5 kN/m <sup>2</sup> |

## Site Conditions

9. Ground Conditions
 

0.0m – 1.0m	Made Ground
1.0m – 3.0m	Medium Dense sand, N=26
3.0m – 6.0m	Dense Sand, N=38
Below 6.0m	Sandstone, safe bearing capacity 1200 kN/m <sup>2</sup> (shear wave velocity = 1350m/s)

Groundwater table is at 2.0m below ground level.

10. Figures 2 and 3 show the design 5% damped seismic response spectrum for the region. It applies to level ground for a 475-year return period assuming the ground surface is rock with shear wave velocity of not less than 800m/s.

## Section 1

**(60 Marks)**

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

## Section 2

**(40 Marks)**

Carry out design checks on key members/connections of the lateral load resisting system including a beam, column, bracing/shear wall, and foundation for the proposed scheme.

Discuss the impacts on the scheme if plant items are moved to the roof.

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