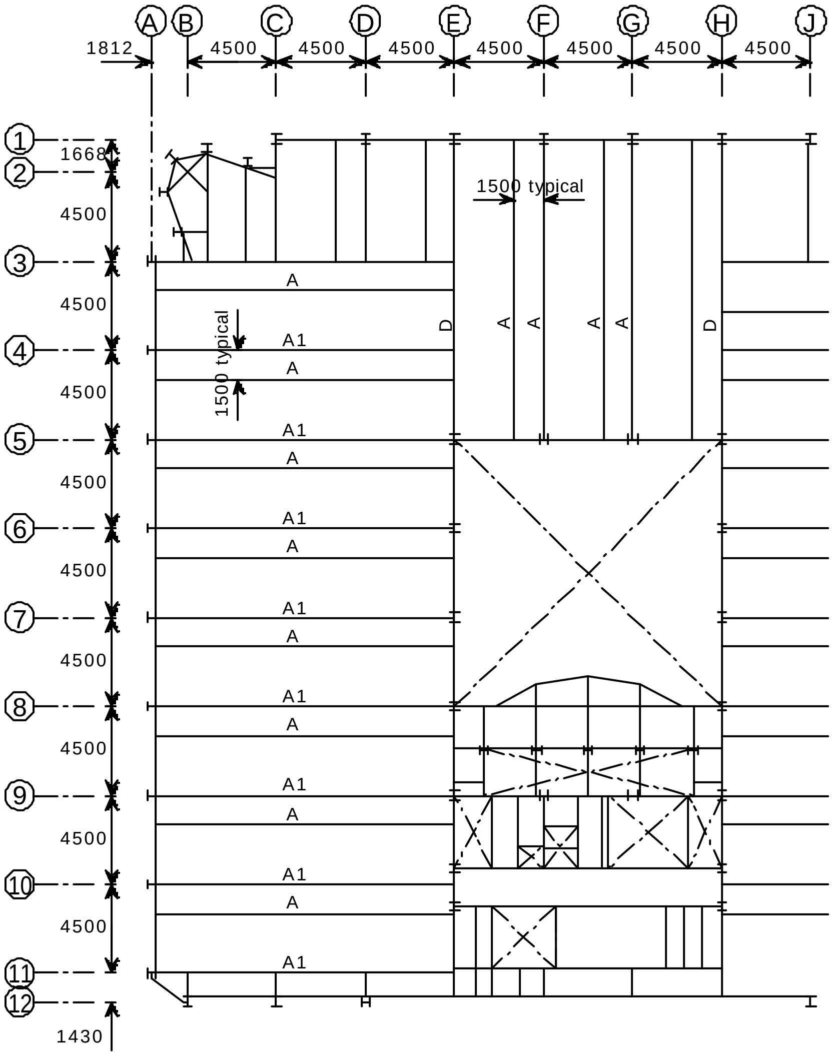
London Office 1

London Office 1 is a typical composite steel framed building using long-span construction. In order to provide uninterrupted areas of office space, the structural solution adopted cellular beams. On plan, a large 13.5 × 13.5 m atrium is located within the centre of the building, with 4.5 m span primary beams trimming this area, as well as the external perimeter of the building. These beams have the dual purpose of supporting the long-span secondary beams, as well as the cladding loads. The 15.3 m long secondary beams, comprising of symmetric and asymmetric cellular beam sections, span from the atrium to the exterior building line, with spacing at 1.5 and 3.0 m centres. The composite floor slab consists of 140 mm deep lightweight concrete on a 0.9 mm gauge Ribdeck 60 trapezoidal decking by Richard Lees Steel Decking Ltd. A part-plan of the building is shown in Figure 1 below.

As expected, from an analysis of the floor area using the principles given within the SCI design guide (see section 1.1.2 of report of Design for Vibrations of Long Span Composite Floors), it was predicted that the vibration mode, which gave the lowest natural frequency, arose from the motion of the secondary beams, which behaved as simply-supported elements. The reason for this was that the primary beams were located around the periphery of the building, which meant that the full height external cladding provided a stiffening effect to these members: thereby causing them to behave as nodal lines.

From a hand analysis, and using permanent loads consistent with that which were present on the floor at the time of testing, it was estimated that the fundamental frequency would be 4.06 Hz. Also, although all of the non-structural components had been installed, the floor was without office furniture. Thus, for all intents and purposes, the floor was considered to be semi-bare, and it was expected that, from the SCI design guide, the level of damping would be about 1.5%.



Main beam sizes:

Floor beam A	*742 mm deep cellular beam 457 × 191UB74 top and bottom with 590 mm diameter cells at 740 mm centres.*
Floor beam D	*804 mm deep cellular beam 762 × 267UB173 top/356 × 406UC340 bottom with 500 mm diameter cells at 740 mm centres.*

Figure 1 General arrangement of London Office 1

Impact tests using instrumented hammer excitation were undertaken at a number of selected positions around the third floor, in order to identify a critical area. From the transfer function, the lowest frequency was found in panel bounded by grid-lines A, E, 3 and 5, with a well-defined peak at 6.3 Hz (see Appendix F of report of Design for Vibrations of Long Span Composite Floors). Furthermore, a second, higher mode was revealed in this area with a frequency of 11.7 Hz.

It was discovered that the damping for the 6.3 Hz mode was very high, with a value 4.1%. However in the adjacent floor panel, bounded by grid-lines A, E, 5 and 7, the damping for only a slightly higher vibration mode of 6.8 Hz was strangely, considerably lower, with a value 2.6%.

From this experimental investigation, it can be seen that the estimated fundamental frequency was approximately 55% lower than that measured on the actual floor. A possible reason for this disparity may be due to the *in situ* stiffness exhibited by the beam-to-column joints. With respect to the damping values, these were derived from fitting a single-degree-of-freedom (SDOF) model to the peak of the transfer function (see figure 3.1 of section 3.1.1 of report of Design for Vibrations of Long Span Composite Floors), at the frequency under consideration. On this particular floor, the two frequency modes of 6.3 and 6.8 Hz mean that the peaks in the transfer function were very close together, which brings into question the accuracy of the damping derived from fitting a SDOF model to these peaks.

An experimental method that could have demonstrated whether the *in situ* damping values were consistent would have been by monitoring the decay from a single sine-wave loading. In this type of test, a decay that did not produce a smooth curve, would have indicated whether the accuracy of the damping found from the transfer function was debateable (see section 3.1.1 of report of Design for Vibrations of Long Span Composite Floors). Unfortunately, this type of test was not carried out. Thus, it is concluded that the damping values found on this particular floor, should be treated with suspicion.