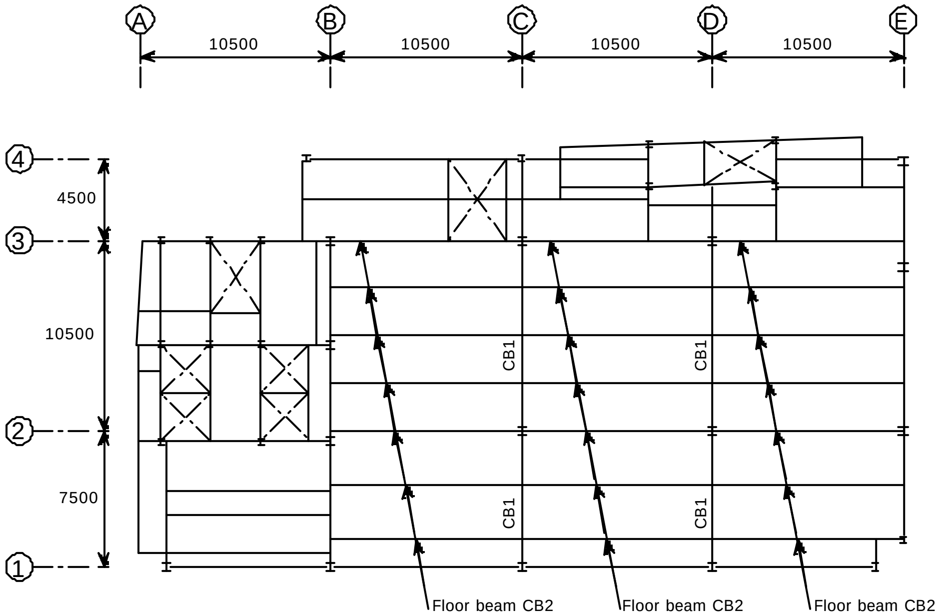
London Office 3

London Office 3 is another excellent example of a composite steel framed building using long-span construction techniques. In order to minimise the floor zone, the structural solution adopted very shallow cellular beams.

On plan, the length of the building is divided into four equally spaced bays at 10.5 m cross-centres, which, in the orthogonal direction, are sub-divided, by three bays spaced at 7.5, 10.5 and 4.5 m respectively. On the left hand side of the building, two 4.85 × 2.35 lift shafts are provided along-side a 4 × 2.3 m stairwell. The composite floor slab consists of 130 mm deep lightweight concrete, on a 1.2 mm thick Super Holorib re-entrant decking by Richard Lees Steel Decking Ltd. A general plan arrangement of the building is shown in Figure 1.



Main beam sizes:

Floor beam CB1	*508 mm deep cellular beam 356 × 368UC202 top and bottom with 300 mm diameter cells at 437.5 mm centres.*
Floor beam CB2	*400 mm deep cellular beam 203 × 133UB30 top/356 × 171UB67 bottom with 250 mm diameter cells at 350 mm centres.*

Figure 1 General arrangement of London Office 3

From an analysis of the floor area using the principles given within the SCI design guide, it was predicted that the vibration mode, which gave the lowest natural frequency, arose from the motion of the primary beams, which behaved as continuous elements.

For this particular project, the floors could be tested in both their bare and finished state, so that valuable information on the change in damping and natural frequency, from the presence of non-structural components, could be obtained. The vibration performance of the floor at these two construction stages is considered separately in the following sub-sections.

Bare floors

Due to the amount of construction work that was being carried out at the time of testing, the only available level where the experimental investigation could be carried out was the third floor. From a hand analysis of the floor using the principles given within the SCI design guide, 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 of the floor would be 5.95 Hz. Also, as the floor was in its bare state, it was expected that the maximum level of damping would be below 1.5%.

In order to identify a critical area on the floor plan, impact tests using instrumented hammer excitation were undertaken at a number of selected positions around the floor (see Appendix H of report of Design for Vibrations of Long Span Composite Floors). From the transfer function, the lowest floor frequency of 6.4 Hz was found in the centre of the panel bounded by grid-lines C, D, 2 and 3. Furthermore, the damping was found to be very high, with a value 4.6%.

Finished floor

The final part of the investigation was carried out on the floor when all of the non-structural components, such as raised flooring, ceiling, etc., had been installed (with the exception of the office furniture). As the installation of these fittings was still being carried out at the time of testing, only the fourth floor was available for the experimental investigation. From a hand analysis of the floor using the principles given in the SCI design guide, 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 of the floor would be 5.59 Hz. Also, as the floor was in its semi-bare state, it was expected that the level of damping would be about 1.5%.

In a similar way as before, impact tests using instrumented hammer excitation were undertaken at a number of selected positions around the floor, in order to identify a critical area (see Appendix I of report of Design for Vibrations of Long Span Composite Floors). From the transfer function, it was again found that the floor in the centre of the panel bounded by grid-lines C, D, 2 and 3, exhibited the lowest frequency. However, the extra mass from the non-structural components did not reduce the floor frequency significantly, and resulted in a value of 6.0 Hz. Strangely, the damping actually reduced for the floor at this level, with a value 3.4%. This may indicate that damping derived from the tests on the (bare) third floor should be regarded with suspicion.

From this experimental investigation, it can be seen that the estimated fundamental frequency was within 7% of the measured frequency, for the floor in both its bare and finished state, indicating very satisfactory performance in the calculation method.

