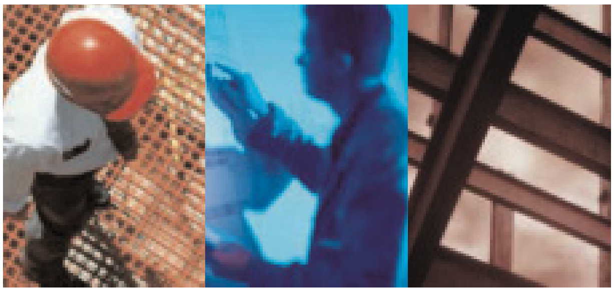
resotec

A BETTER ENVIRONMENT

The Innovative New Damping System with a difference

Case Studies

RICHARD LEES STEEL DECKING



Case 1

Consider a single span rectangular floor bay comprising 406x174UB54 beams - spanning 10.00m and spaced at 3.00m c/c's. The bay is 30.00m wide.
A Ribdeck AL trapezoidal decking is used with 130mm lightweight concrete. It can be shown that the floor has a fundamental frequency of around 6Hz, and a response factor of 6.1, for walking at around 2Hz and assuming 3% of critical damping.

By making the floor beams partially composite for the central 50% of their length and introducing Resotec over the remaining lengths, around 2.6% of additional damping will be provided. The added damping reduces the response factor to 4.3 (a reduction of 30%).

To achieve a similar improvement through stiffness increase, the beam would have to be increased to a 610x229UB101

- **47kg/m increase in steel beam weight**
- **200mm increase in floor zone**
- **500mm increase in surface area for painting/fire protection**
- **1.00m increase in height of a ten storey building**

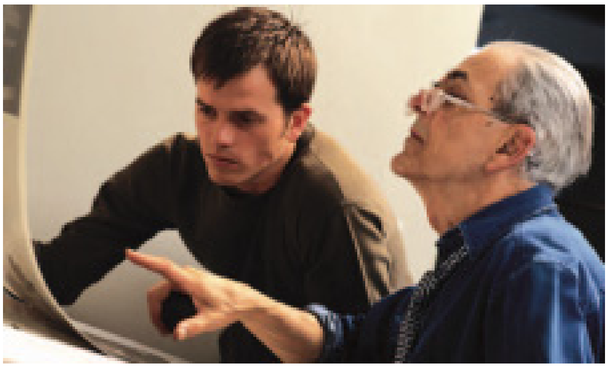
Similarly, to achieve the same improvement through increased mass, the slab could be changed to normal weight and increased in depth to 150mm. Alternatively if lightweight concrete were to be maintained, then the increase in slab depth would be 60mm.

Three examples of the potential benefits that can be achieved from using the

RLSD Resotec Damping System

within composite floor plates, constructed using

Richard Lees Steel Decking profiles.



Case 2

Consider a recently built office block in London with the floor plate being 7 secondary beams at a spacing of 3.00m and spanning 9.00m to form a bay width of 18.00m. The floor was designed for architectural reasons to be of minimum depth, so a 130mm lightweight concrete composite slab using Ribdeck E60 and a shallow 305x165UB46 was chosen. However, when the dynamic performance of the floor was investigated, the first natural frequency of the floor was found to be 5.8Hz and the response factor was shown to be 9.1 (i.e. > 8 the recommended target for a "normal office").

By making the floor beams partially composite for the central 60% of their length and introducing Resotec over the remaining end portions, the response factor was reduced to 6.6 and the dynamic performance of the floor improved by 30% without any increase in steel weight. A further reduction of around 10% could have been achievable if the beam was increased one size to a 305x165UB54. That would facilitate reducing the composite section to 50% of the total length without compromising its strength and the resulting response factor would become 5.9.

To put this performance into context, the same 30% benefit could be achieved by either:

- **Adding mass. An increase of 50% in self-weight is required. Change to a heavier Holorib profile with normal weight concrete and a 305x165UB54.**
- **120kg/m² increase in concrete weight**
- **8kg/m increase in steel beam weight**

or:

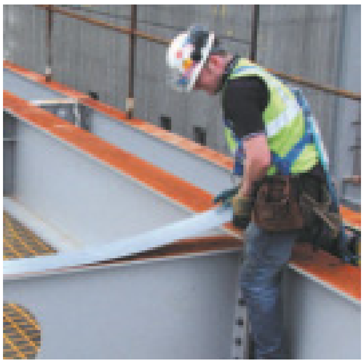
- **Increasing the frequency so the floor becomes a high frequency floor. A first mode frequency above 10Hz is achieved using a 457x191UB98 with the same lightweight concrete slab.**
- **44kg/m increase in steel beam weight**
- **152mm increase in floor zone**

Case 3

Another recently built office floor is constructed with secondary beams spanning 12.00m at a spacing of 3.00m. 12 No. 457x191UB secondary beams form a typical bay of 12.00 x 33.00m. The slab is 130mm C30 lightweight concrete with 0.9mm gauge Ribdeck E60.

Assessment of the floor slab yields a natural frequency of the first mode of 5Hz and a response factor of 5.6. Such a response factor is well within the SCI recommendation of 8, and with such dynamic performance would not be expected to attract adverse comments. Nevertheless, when the floor space was occupied for office use, some complaints were made about perceived floor vibration.

The complaints prompted vibration measurements to be taken on an equivalent, bare floor slab and these revealed a response factor of as high as 10, but without any superimposed dead or live load. A desk study of the dynamic performance of the bare floor suggested response factors similar to those measured. This indicates that the analysis of the occupied floor space was inaccurate in the assumption for imposed/live load; this load is usually taken as the dead load plus10% of the static live load in line with SCI-P-076.



The Structural Steel Design 2004 award winning MORE London Plot 1

(photo courtesy ARUP)

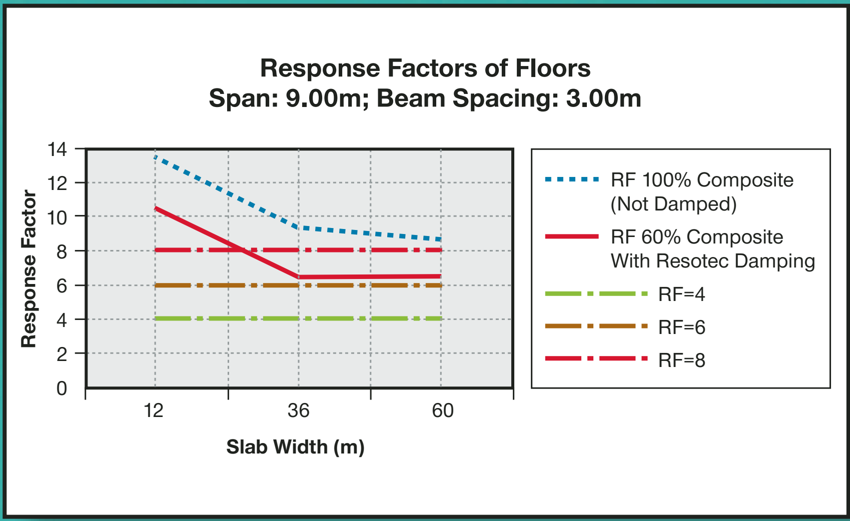
and innovation in action as Resotec is applied to its beams.

A more realistic assessment of dead and live loads actually present in modern offices is significantly lower than that taken and if this was appreciated at the design stage then a response factor of around 8 would have been revealed; clearly more likely to attract criticism. It is worth noting that the assumption of the floor loading affects the response factor both directly through affecting the modal mass and indirectly by altering the frequency content of the floor. While higher loading is beneficial to the response through increased modal mass, the corresponding reduction in natural frequency will tend to be adverse. Overall, the affect of increasing mass is generally beneficial to the floor performance.

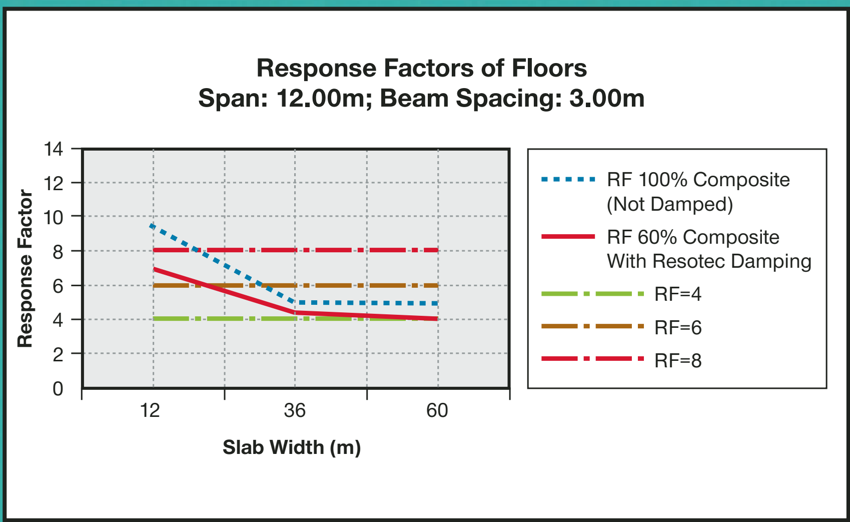
The potential for reducing the response factor of the floor to footfall vibration through the use of Resotec has been studied and in this case, the beams may be made 50% composite without compromising the static design criteria. The frequency of the first mode of vibration is consequently reduced to 5.4Hz. However the damping in the same mode is a high as 5.6% of critical, which results in a significantly reduced possibility of resonant oscillations building up.

- **Assessment of the dynamic performance of the floor based on these damping characteristics results in a response factor of 4.3**
- **A substantial improvement without requiring any further changes to the design**

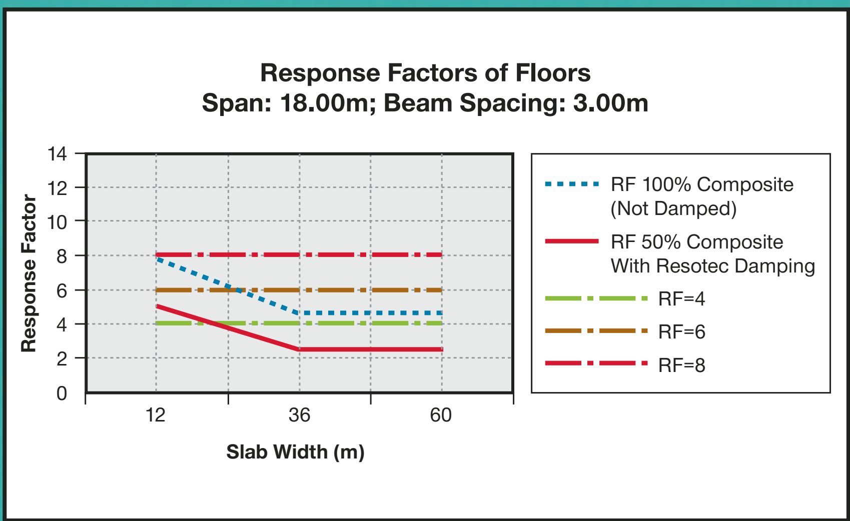
Indicative slab dynamic performance graphs



Beam type: 406x140UB46, S275
Slab: 130mm lightweight concrete, 0.9mm Ribdeck AL
Static load: 5kN/m2
Additional dead load 0.5kN/m2
Dynamic load: 0.5kN/m2



Beam type: 457x194UB74, S275
Slab: 130mm lightweight concrete, 0.9mm Ribdeck AL
Static load: 5kN/m2
Additional dead load 0.5kN/m2
Dynamic load: 0.5kN/m2



Beam type: 686x254UB140, S275
Slab: 130mm lightweight concrete, 0.9mm Ribdeck AL
Static load: 5kN/m2
Additional dead load 0.5kN/m2
Dynamic load: 0.5kN/m2

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The only analysis tool that can predict the damped floor response achievable with Resotec. Providing automatic stud and section design, Compos is the premiere tool for composite analysis and design.

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