

# AD 433: Dynamic modulus of concrete for floor vibration analysis

The purpose of this AD note is to provide advice on the choice of elastic modulus of concrete when undertaking the vibration analysis of a [composite floor](#).

The elastic modulus of concrete depends on the constituent materials of the concrete mix and on the age of the concrete. It also depends on the duration of loading and whether the concrete is assumed to be cracked or un-cracked. Table 3.1 in BS EN 1992-1-1 gives strength and deformation characteristics for concrete by strength class. The values are tabulated for normal weight concrete with quartzite aggregates and are based on the cylinder strength  $f_{ck}$  at 28 days. The formula for the secant modulus  $E_{cm}$  is:  $E_{cm} = 22[(f_{ck}+8)/10]^{0.3}$ .

The value is in GPa when the cylinder strength is in MPa. Adjustments to the values for quartzite aggregates are given for limestone, sandstone and basalt aggregates. Practice in continental Europe is to use a dynamic modulus based on  $E_{cm}$  enhanced by 10%<sup>1</sup>.

In UK practice, values for elastic modulus determined from the code are not considered suitable for the calculation of beam deflections

from which the natural frequency of the beam is to be determined. The [dynamic behaviour](#) generally involves small amplitude vibrations to which the secant modulus at 28 days  $E_{cm}$  is not relevant. Instead, given the uncertainty regarding the parameters which affect the actual properties of concrete (type of aggregate, age of concrete, compressive strength etc.), an approximate dynamic modulus should be used which (from practice) gives reasonable results.

SCI publication P354 *Design of floors for vibration: a new approach*<sup>2</sup> and Concrete Centre publication: *A design guide for footfall induced vibration of structures*<sup>3</sup>, both recommend the same values for the dynamic modulus of concrete which is appropriate for the estimation of the dynamic response of composite or concrete structures. Values are given for normal weight and light weight concrete as follows:

Uncracked concrete	Dynamic modulus (GPa)
Light weight	22.0
Normal weight	38.0

When using references 2 and 3, the stated values for dynamic modulus should not be enhanced by 10%.

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## References

1. European Commission – Technical Steel Research: *Generalisation of criteria for floor vibrations for industrial, office, residential and public building and gymnastic halls*, RFCS; Report EUR 21972 EN, ISBN 92-79-01705-5, 2006.
2. Smith, A L, Hicks, S J, Devine P J, *Design of floors for vibration: a new approach*, Revised edition, February 2009, SCI publication P354
3. Willford, M R, Young, P, *A design guide for footfall induced vibration of structures*, Concrete Centre, November 2006