CDM / REUTENBEEK 9 - 11 / BE-3090 OVERIJSE / BELGIUM / T: +32 2 687 79 07 / F: +32 2 687 35 52 / www.CDM.be

MANUFACTURER'S STATEMENT

- CONCERNS: influence of the air stiffness in high performing floating floors with discrete isolators
- DATE: 26-04-2010
- COUNTRY: USA
- CDM CONTACT: business partner RPG
- PROJECT / REF.: undefined

To whom this may concern,

CDM is specialized (since 1951) in high performing isolation systems for buildings, industry and track infrastructure with respect to noise & vibrations. CDM is active worldwide and supplies engineering & products through a network of own companies as well as exclusive business partners (like RPG for the USA).

One of the main CDM applications is floating floors based on discrete isolators (= made of elastomers or steel springs), as this can result in extremely high levels of isolation. However, in such setups, the stiffness of the air which is "trapped" between the isolators becomes important and cannot be neglected. The total dynamic stiffness (Kd) of the floating floor is then the sum of the stiffness of the isolators (Kdi) and the stiffness of the air (Kda). Kd is directly related to the "system resonance frequency" of the floor and thus to the isolation performance, so it is important to indeed consider the stiffness of the air. In some cases, Kda can even be > Kdi.

The stiffness of the air layer is generally calculated as follows: $Kda = \rho * c^2 / t$

ρ = the density of the air
c = the speed of sound through air
t = the thickness of the air layer

In metric units, $\rho = 1{,}2 kg/m^3$ and $c = 340 m/s$ so one gets $\rho * c^2 = 138720 N$ for $1 m^2$ of floor.

Usually however, the void between the isolators is filled (for approx. 80% of the surface) with an absorptive material like mineral wool or similar to avoid wave reflections in the void, also referred to as

CDM NV-SA / Reutenbeek 9-11 / BE – 3090 Overijse
T : +32 2 687 79 07 / F : +32 2 687 35 52
BTW/TVA BE 0428.322.207 / RPR Brussel

CDM / REUTENBEEK 9 - 11 / BE-3090 OVERIJSE / BELGIUM / T: +32 2 687 79 07 / F: +32 2 687 35 52 / www.CDM.be

"standing waves". Such material creates a kind of "adiabatic effect", i.e. it slightly reduces the air stiffness, so a generally accepted value for $\rho * c^2$ = 110000N, which is used as a constant (in Europe).

It may be clear that the stiffness of the air will play a role only when the air is indeed "trapped" inside the floating floor system. This certainly is the case when the perimeter is completely closed off (by means of a resilient material), but also for large floating floor systems with open perimeters: indeed, when the size of the floor is larger than 4m x 4m, the air trapped in the middle of the floor has to travel more than 2m to get out… and when there is absorptive material in the void (usually the case!), such a distance becomes problematic… CDM therefore recommends not to fill the air gap completely over the entire thickness, but to leave at least a couple of mm open for the air to move (Remark: consider the static deflection of the isolators!). So, the air stiffness can only be neglected for rather small floors with fully open perimeter. Of course, the total floor stiffness will not change abruptly for open floors larger than 4m x 4m… one may expect a gradual increase of the stiffness, but unfortunately there is very little test data available on this matter. The main reason for this is that the standardized acoustical labs are too small (max. 5m x 5m), so it is simply not possible to correctly test the effect of the air stiffness with increasing floor size. As a result, to be on the safe side, the air stiffness is usually taken up in the calculations for floating floor systems unless it concerns a small floor with fully open perimeter, limited to 4m x 4m…

Acoustical measurements on site (STC, IIC) show the resonance frequency of the floor system, and prove the effect of the trapped air; e.g. when considering isolators resonating at 5Hz, such measurements will normally indicate a floating floor resonance frequency situated between 10 and 15Hz due to the stiffness of the air, corresponding to the constant of 110000N indicated above.

To conclude, as for most practical applications the air stiffness will be an important factor, the only practical way to minimize this effect is by increasing the constrained air layer thickness. Since that thickness is in the denominator (as shown above), increasing it will lower the Kda and hence lower the system resonance frequency. CDM offers a transmission loss prediction program (xls-format) based on the "Prognosis Method", in which the effect of the air thickness can be estimated. Please contact RPG for a copy of the program. A "White Paper" is also available on their website:

www.rpginc.com/products/cdm/whitepapers/Floating Floor TL Prediction using the Prognosis Method.

Increasing the air layer thickness can be done for instance by using "sleepers" beneath the elastomers, made of wood, fiber-cement, etc.

We hope that the actual statement may shine some light on this complex matter…

Ir. Michael Vanstraelen
Manager CDM B & I engineering
michael.vanstraelen@cdm.be