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COMMENTS ON "STUDY OF THE FORCED RESPONSE OF A CLAMPED CIRCULAR PLATE COUPLED TO A UNI-DIMENSIONAL ACOUSTIC CAVITY"

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The authors are to be congratulated for their interesting and useful experimental and analytical study of a structural acoustics coupling problem [1].

As stated by the authors, the vibrating structure (a clamped circular plate) coupled to the acoustic cavity is modelled as a mass–spring–damper oscillator (M, K, C). A good agreement between experimental and analytical results has been obtained by the authors by assuming $M = 2$ kg (according to the authors, but about 50% greater than the true mass of the plate).

It is interesting to point out that the determination of equivalent mass and compliance corresponding to the fundamental mode of vibration has been determined, in a rather accurate fashion, in recent studies [2–4]. Such determinations are of interest when dealing with electro-acoustic analyses.

In the case of a clamped circular plate, the ratio M_0/M_p, where M_0 is the equivalent mass and M_p is the actual mass of the plate, is equal to $9/5 = 1{\cdot}80$. According to the dimensions of the experimental set-up developed by the authors and to the assumed value of the equivalent mass considered by the authors (2 kg), the ratio M_0/M_p is approximately equal to 1·74, which is in good engineering agreement with the value available in the literature [2–4] and which has been previously quoted. An equivalent mass and compliance for the fundamental mode of vibration can be conveniently determined using a polynomial approximation, which is valid for the general case of a plate elastically restrained against rotation at the edge [5].

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AUTHORS' REPLY

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In reference [1], both theoretical and experimental analyses on the dynamic interaction between a uni-dimensional cylindrical acoustic cavity (internal diameter $d = 306$ mm) and a coupled flexible plate (theoretical thickness $s = 2$ mm) are carried out.

The vibrating circular wall is modelled as a mass–spring–damper oscillator. Good agreement betwen the experimental and the analytical results has been obtained by assuming that $M_e = 2$ kg (where M_e is the equivalent mass of the plate).

The actual thickness of the free-edge plate (radius $a_p = 220$ mm, weight $M_{a_p} = 2{\cdot}329$ kg), is $s_p = 2{\cdot}011$ mm. The actual mass of the vibrating clamped plate (radius $a = 153$ mm) is then $M_p = 1{\cdot}147$ kg. In this case the ratio M_e/M_p is approximately equal to 1·74.

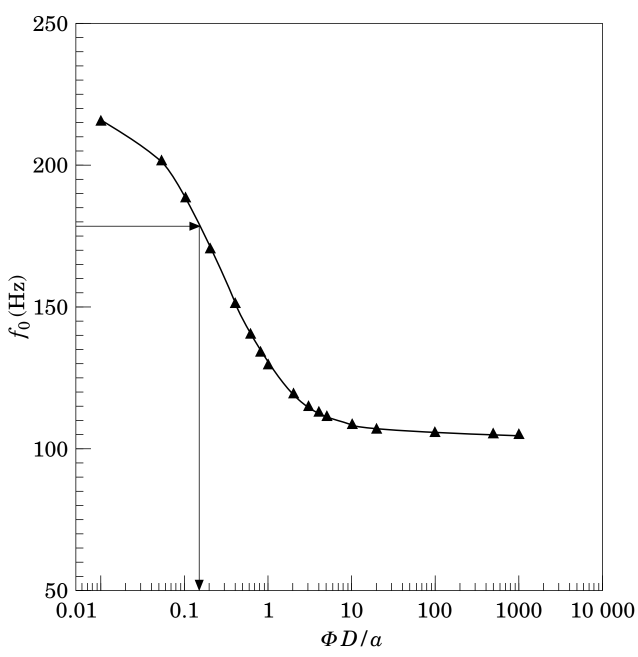

Figure 1. Variation of the fundamental frequency of a circular plate ($s = 2$ mm) with respect to $\Phi D/a$.

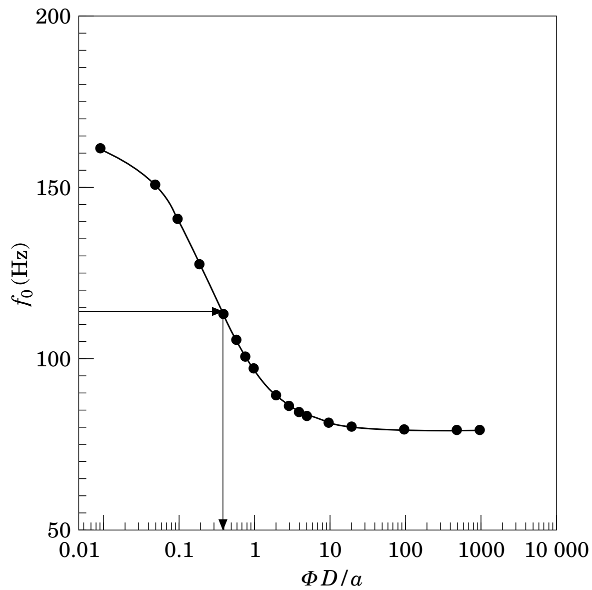

Figure 2. Variation of the fundamental frequency of a circular plate ($s = 1{\cdot}5$ mm) with respect to $\Phi D/a$.

In Figure 1 is shown the fundamental frequency f_0 of the plate (calculated by means of the equations obtained in reference [2]) with respect to $\Phi D/a$ (where D is the flexural rigidity and Φ is the distributed spring constant of the elastic restraint of the panel held at the periphery). The fundamental measured frequency of the clamped plate [1] is equal to 178 Hz (which corresponds to $\Phi D/a = 0{\cdot}149$). The ratio M_e/M_p (corresponding to $\Phi D/a = 0{\cdot}149$) calculated by means of the expressions given in reference [3] is equal to 1·567.

The results of experiments carried out on a clamped panel (thickness $s = 1{\cdot}5$ mm) coupled to the above described cylindrical cavity are given in reference [4]. The equivalent mass is assumed to be $M_e = 1{\cdot}5$ kg. The actual thickness of the free-edge plate (radius $a_p = 220$ mm, weight $M_{a_p} = 1{\cdot}726$ kg) is $s_p = 1{\cdot}491$ mm. The actual mass of the vibrating clamped plate (radius $a = 153$ mm) is $M_p = 0{\cdot}86$ kg. Also in this case the ratio M_e/M_p is approximately equal to 1·74.

In Figure 2 is shown the fundamental frequency f_0 of the panel with respect to $\Phi D/a$. The fundamental measured frequency of the clamped plate [4] is equal to 114 Hz (which corresponds to $\Phi D/a = 0{\cdot}383$). The ratio M_e/M_p (corresponding to $\Phi D/a = 0{\cdot}383$) is equal to 1·486.

Both of the analyses performed in references [1] and [4] are experimentally to verify the mathematical method described in reference [3] for the determination of the equivalent mass corresponding to the fundamental mode of vibration of a circular plate held at the periphery.

The results obtained confirm good engineering agreement between the theoretical values available in the literature [2, 3] and the experimental ones previously quoted. In effect, the discrepancies observed between the experimental and calculated M_e/M_p ratios are probably due to the fact that the two flanges holding the plate have deformable smoothed edges. The actual diameter of the vibrating plate then increases and the corresponding ratio M_e/M_p is reduced.

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