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LETTERS TO THE EDITOR

COMMENTS ON "OPTIMAL SUPPORT POSITIONS FOR A STRUCTURE TO MAXIMIZE ITS FUNDAMENTAL NATURAL FREQUENCY"

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In excellent paper Won and Park [1] have developed a procedure to find the loci of optimal support positions of a structure, while varying its supports stiffness, in which the fundamental eigenvalue of the structure is maximized. As shown by the authors, the end positions of the loci are located on the nodal line of the $(m + 1)$th eigenfunction if the fundamental eigenvalue of the modified structure can be increased to the $(m + 1)$th eigenvalue of the original structure. In the case of infinite support stiffness, these positions are the optimal support positions.

It is also the purpose of the present letter to discuss briefly two studies previously published in the *Journal of Sound and Vibration* [2, 3] which are in agreement with the conclusions of the paper by Won and Park although the scope of references [2, 3] is much more limited and modest.

Reference [2] presents values of fundamental frequency coefficients of the system shown in Figure 1 when the edge $x = 0$ is (a) clamped and (b) simply supported. The effect of the position of the internal support placed at $x = x_1$ was investigated; see Figure 2.

It can be seen that the maximum values of the two curves shown in Figure 2, occurring at approximately $x_1/a = 0{\cdot}75$, are in good engineering agreement with the eigenvalues for the original structure (the plate without internal support) when the plate vibrates with one wave in the y-direction and a nodal line parallel to the y-axis which is located at approximately $x_1/a = 0{\cdot}75$. In the case of a square plate with three edges simply supported while the fourth is free, one has $\Omega_{21} = 27{\cdot}8$. When edges $y = 0$, b are simply supported and $x = 0$ is clamped, the eigenvalue is $\Omega_{21} = 33{\cdot}06$. The maxima of the curves depicted in Figure 2 are slightly higher than these two eigenvalues due to the fact that they have been obtained by means of the optimized Rayleigh–Ritz method and this approach yields upper bounds.

Reference [3] deals with (1) clamped and simply supported circular plates and (2) circular membranes. The effect of concentric–circular and secant supports was investigated.

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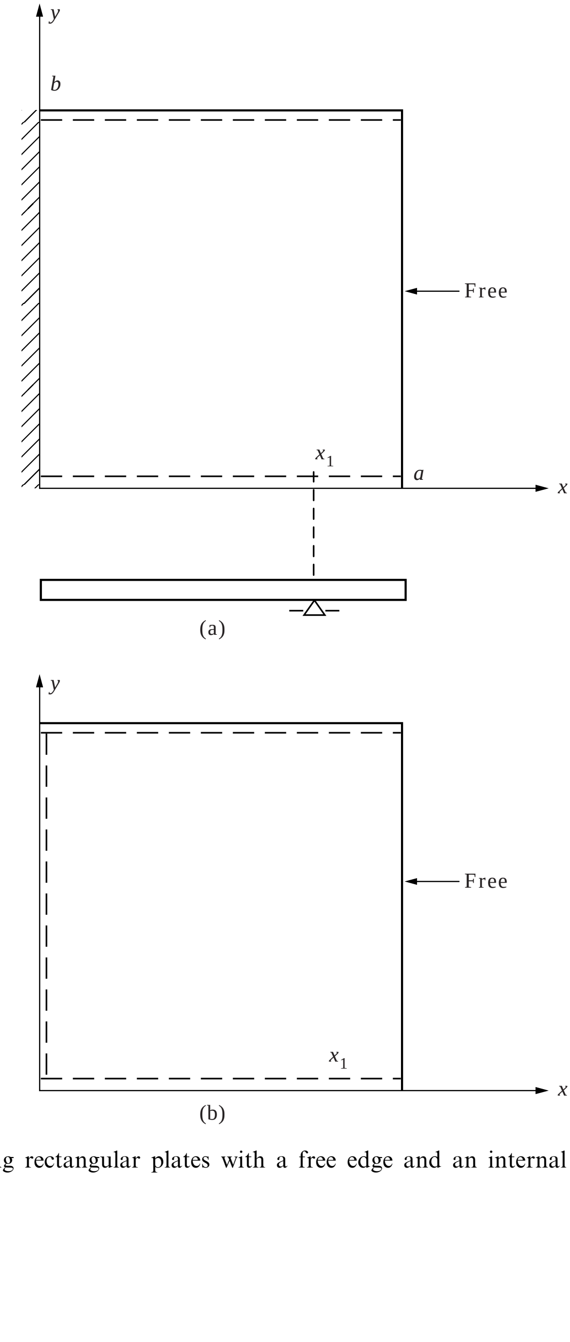

Figure 1. Vibrating rectangular plates with a free edge and an internal support considered in reference [2].

Figure 3 depicts the variation of the fundamental frequency coefficient $\Omega_1 = \sqrt{(\rho h/D)}^{1/2}\omega_1 a^2$ of clamped and simply supported circular plates with a concentric circular support.

In the case of a clamped plate the maximum value is approximately 40 and occurs at $R_0/a \cong 0{\cdot}38$, the second frequency coefficient corresponding to axisymmetric modes being 39·771 in the unmodified structure.

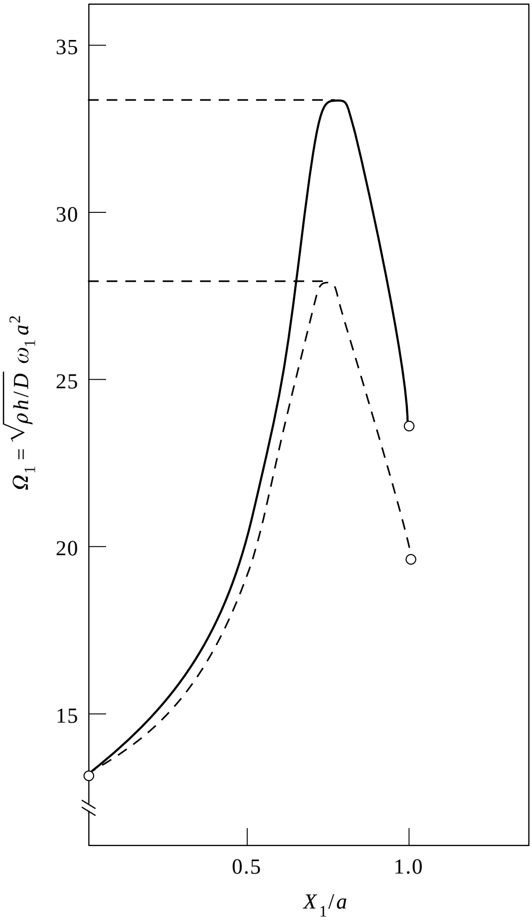

Figure 2. Variation of the fundamental frequency coefficient $\Omega_1 = \sqrt{(\rho h/D)}^{1/2}\omega_1 a^2$ of the structural systems in the case of square plates, as shown in Figure 1 for (a): edge $x = 0$, clamped (——) and (b): edge $x = 0$, simply supported (- - -) [2].

When dealing with the simply supported plate the maximum value of Ω_1 is approximately 30* and the second frequency coefficient of the unmodified structure mode is $\Omega_{10} = 29{\cdot}72$, also for $\mu = 0{\cdot}3$, and occurs at $R_0/a \cong 0{\cdot}45$.

In the case of membranes with concentric circular supports the conclusions are similar and also when dealing with circular plates and membranes with a secant support.

As a concluding remark it may be stated that the results presented in references [2, 3] are particular cases of the general theory presented in reference [1].

It appears that the supports of infinite stiffness do possess optimum effects, from the point of view of raising the fundamental frequency, when they are

*Determined using Poisson's ratio equal to 0·3.

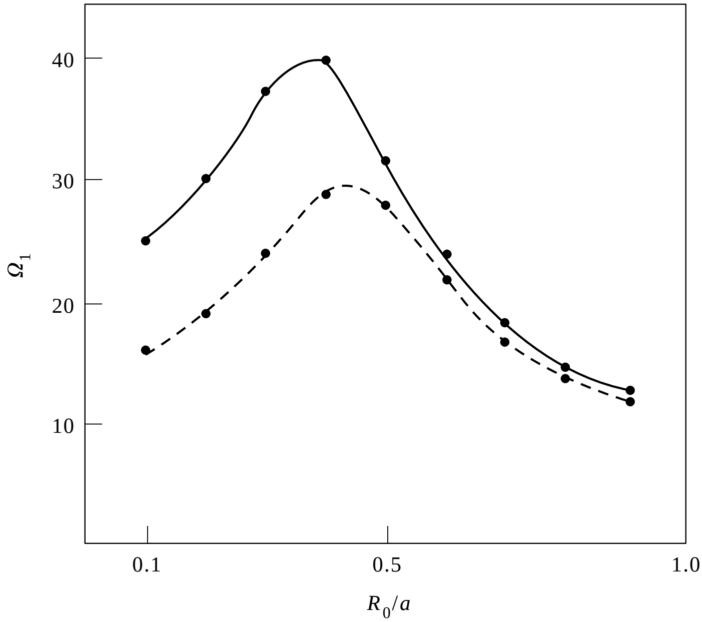

Figure 3. Variation of the fundamental frequency coefficients of clamped and simply supported circular plates of radius a, with a concentric circular support of radius R_0, as a function of the parameter R_0/a [3]: —, clamped outer boundary; - - -, simply supported outer boundary.

placed on loci of points belonging to higher eigenmodes of the unmodified structure and in turn these points correspond to dynamic states of the structure where the energy flow is most efficient.

ACKNOWLEDGEMENTS

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