SIMPLE RULES FOR TRUNCATION OF PERIODIC STRUCTURES TO ACHIEVE A PRESCRIBED BANDGAP ATTENUATION LEVEL

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ABSTRACT

The recent increasing interest in periodic structure, especially in connection with photonic bandgap materials, has created an urgent demand for robust methods of analysis and design of these structures. Despite the fact that in practice, periodic structures are truncated after a finite numbers of unit cells, the analysis is usually carried out under the assumption of true periodicity. The response of the truncated structure is then assumed to reproduce that of the periodic infinite structure. To the best of our knowledge, the important issue of how to decide on the number of periods to maintain a prescribed attenuation level in the bandgap has not been adequately addressed.

The work reported in this presentation is a first step towards setting simple rules to determine the number of periods in the synthesis of a truncated periodic structure. Starting from the infinite periodic structure, the attenuation constants of the relevant modes in the bandgaps as a function of frequency are first determined. Let α denote such a quantity. If the input and output to and from the truncated structure are assumed matched, then the number of periods N required to achieve an insertion loss L^{obj} dB is given by the approximate formula

$$N \approx \frac{L^{obj}}{8.686 \alpha p} \tag{1}$$

Here, p is the period of the structure. This formula has been applied to 1-D periodic structures to test its accuracy. In most cases, it gives accurate values for the number of periods.

The presentation will also address other features of corrugated waveguides with continuous corrugation profiles. The effect of the shape of the corrugation profile on the propagation properties of the structure are investigated at the examples of rectangular waveguides with sinusoidally oscillating narrow walls. Triangular corrugations are also investigated.