

Applying of Schroder Type Diffusers Combined with Perforated Sheet and Advanced Architecture Materials for Noise Reduction/ Diffusing

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Abstract:

This Presentation shows that using of Schroeder diffusers, often used in architecture in combination with perforated sheets can lead to effective solutions for noise reduction of noise at source.

When Schroeder diffusers are mounded within irregular protuberances to the interior of the aircraft wing in areas placed above the engines, jet noise is partially absorbed in broad band and noise reflected to community is reduced. This solution is preferable to using of classic acoustic liners on the pressure side of wing, over engines because noise is absorbed in broad band and scattered.

In the case of cities, if Schroeder diffusers are applied on facades of buildings which are placed around airports, noise is diffused and the annoyance produced by aircraft noise is decreased.

Outline

- 1. Introduction**
- 2. Applying of Schroeder diffusers combined with microperforated sheet on wing pressure side, over engines**
- 3. Influence of acoustic liner and Schroeder diffuser & perforated sheet on reflected noise**
- 4. Using of Schroeder diffuser in advanced architecture design for lining of buildings' exterior around airports**
- 5. Conclusions**

1. Introduction

- In time, Architecture as art and science accumulated an exceptional experience which can be transferred now for reduction of annoyance produced by aircraft noise
- For example, Schroder diffusers (fig.1, [1]) are very efficient in scattering of noise and reduction of its local intensity and implicitly of annoyance in internal spaces (meeting rooms, conference rooms etc.)
- In the last time, Schroeder diffusers based on acoustic metastructures [2] achieved a good efficiency for dimensions of only 5% of wavelength



Fig.1- Schroder diffusers used in architecture [1]

[1]- <https://flypaper.soundfly.com/produce/how-to-build-an-acoustic-diffuser/>

[2]- Yifan Zhu, Xudong Fan, Bin Liang, Jianchun Cheng, and Yun Jing, Phys. Rev. X 7, 021034 , 5 .06.2017, Ultrathin Acoustic Metasurface-Based Schroeder, Diffuser, <https://journals.aps.org/prx/abstract/10.1103/PhysRevX.7.021034>

2. Applying of Schroeder diffusers combined with microperforated sheet on wing pressure side, over engines

- At the present configuration of aircraft the jet noise is strongly reflected by wing to community (fig. 2)
- A Schroeder structure placed over the engine should scatter the incident noise on pressure side of wing (fig.3).

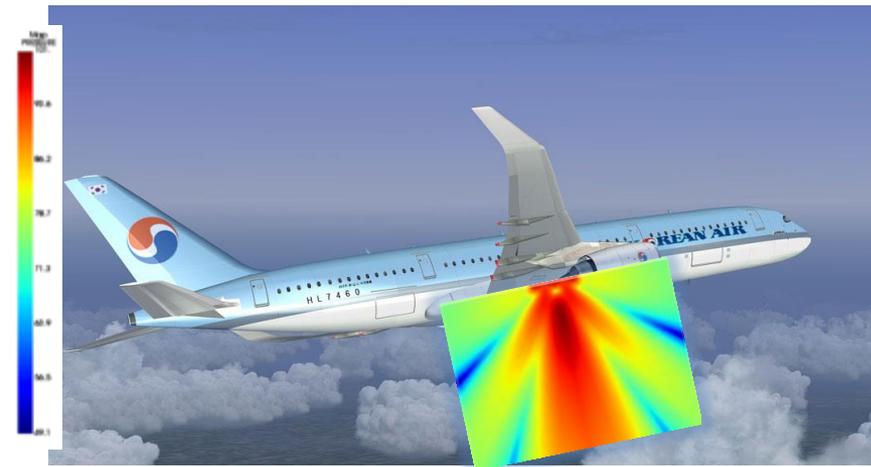


Fig.2- Reflection of jet noise by wing (jet noise was considered a plane wave, 94 dB)

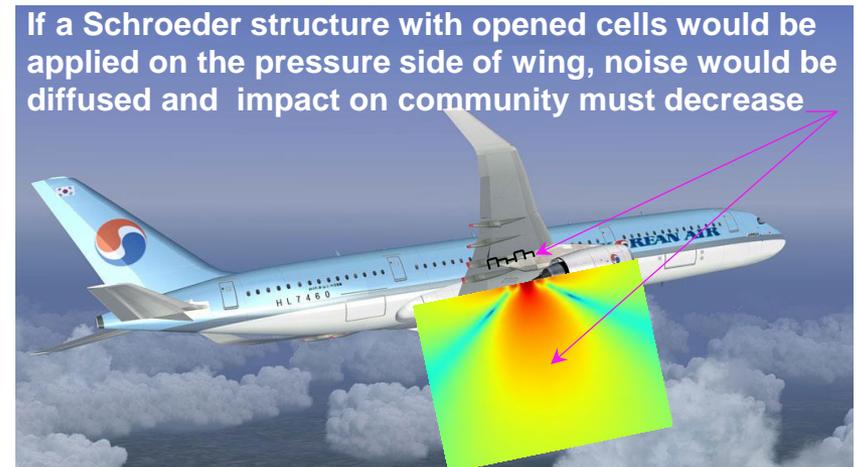


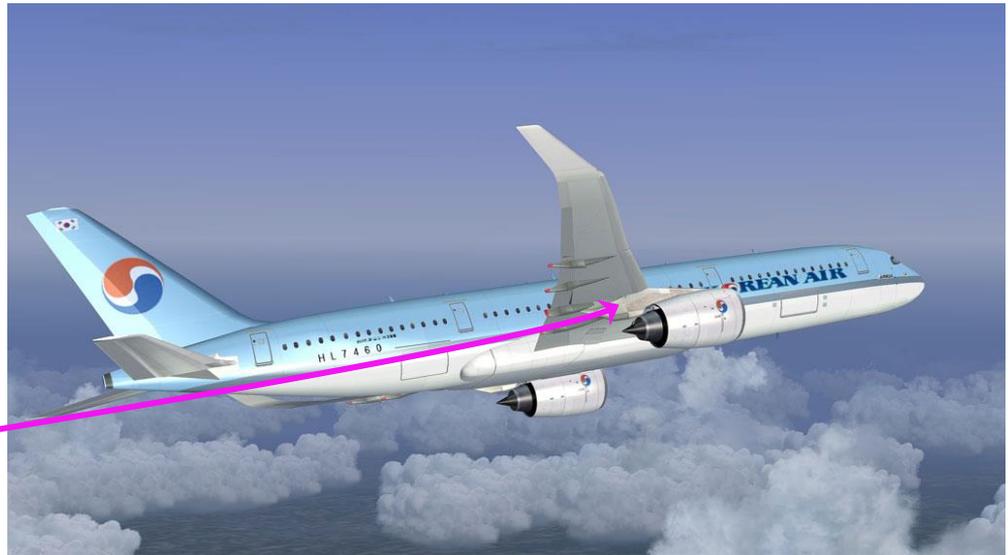
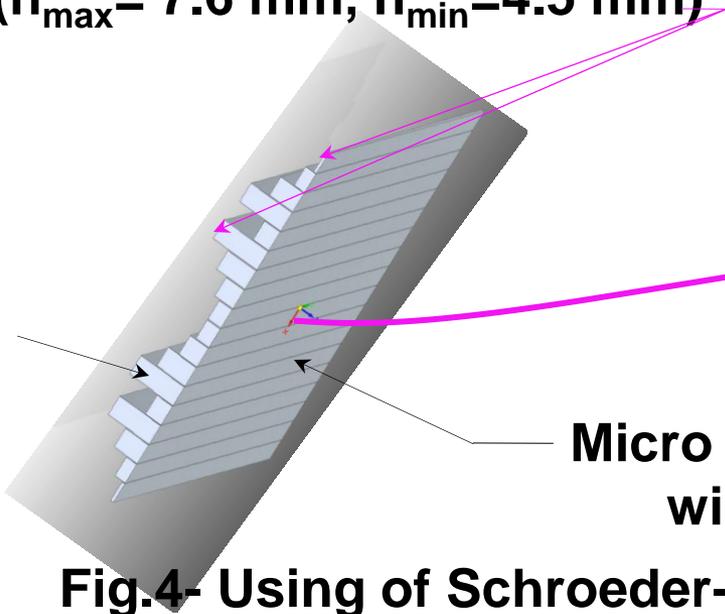
Fig.3- Reflection of jet noise by a Schroeder structure (jet noise was considered a plane wave, 94dB)

- However, Schroeder structure is not an aerodynamic one. This drawback is eliminated if Schroeder diffuser cavities are integrated inside the wing and these are covered by microperforated sheet (see the next slide).

2. Applying of Schroeder diffusers combined with microperforated sheet on wing pressure side, over engines

- When Schroeder structure is composed of deep cavities which are placed inside the wing and the wing pressure side is perforated over the engine, a special acoustic liner with multiple chambers is created (fig.4).
- This acoustic liner can absorb jet noise in broad band. In this way, jet noise intensity reflected to community should decrease and annoyance should decrease accordingly

Schroeder structure (composed of cavities) inside the wing
($h_{\max} = 7.6 \text{ mm}$, $h_{\min} = 4.5 \text{ mm}$)



Micro perforated sheet on the pressure side of wing (#0.7 mm, $\Phi 0.26 \text{ mm}$, $\sigma = 2.37\%$)

Fig.4- Using of Schroeder-acoustic liner on the pressure side of wing over the engine

2. Applying of Schroder diffusers combined with microperforated sheet on wing pressure side, over engines

- Using this combination is productive because noise is simultaneously absorbed and scattered.
- In this way annoyance decreases because, on the one hand noise is absorbed and, on the other hand, noise is scattered and the energy per unit area decreases.

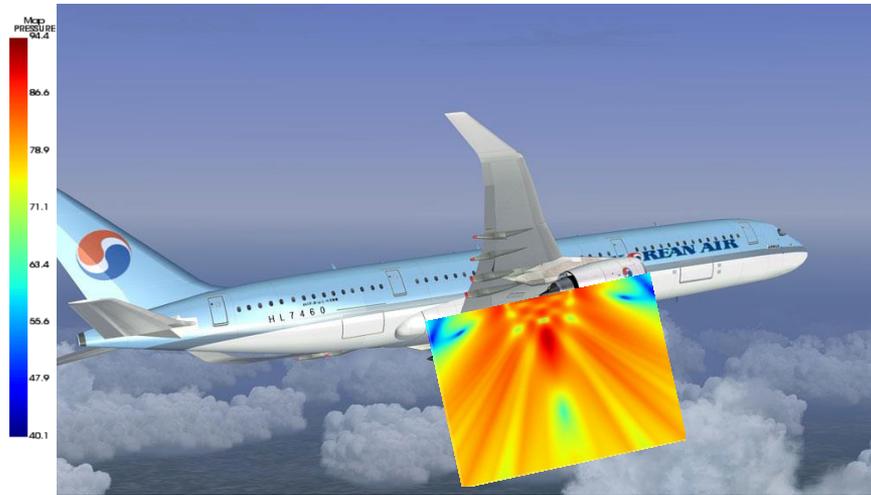


Fig.5- Absorption of noise by a regular acoustic liner (honeycomb structure, $h=20$ mm, $\#0.7$ mm, $\Phi 0.26$ mm, $\sigma=2.37\%$) placed on wing pressure side, over engine

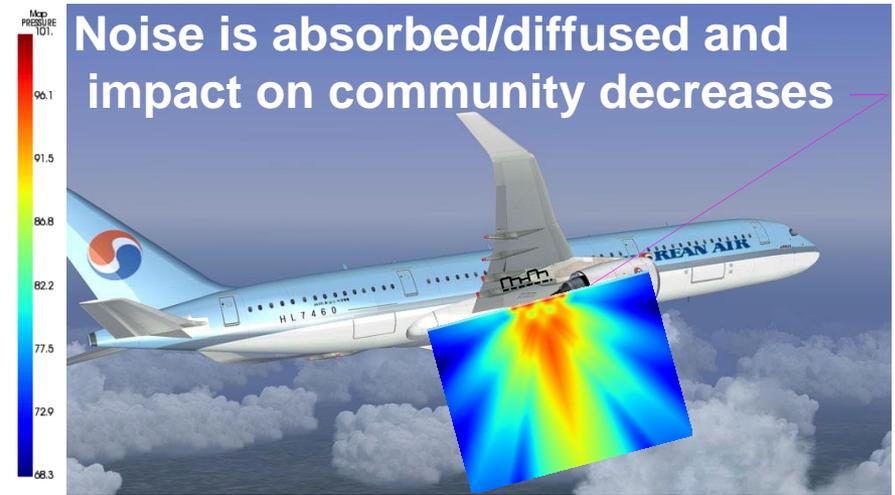


Fig.6- Absorption of noise by a Schroeder diffuser combined with microperforated sheet on wing pressure side over engine ($h_{\max}=7.6$ mm, $h_{\min}=4.5$ mm, $\#0.7$ mm, $\Phi 0.26$ mm, $\sigma=2.37\%$)

3. Influence of acoustic liner and Schroeder diffuser & perforated sheet on reflected noise

- A comparison between the efficiency of various technologies in reduction/ scattering of jet noise reflected by wing is presented in fig. 7.

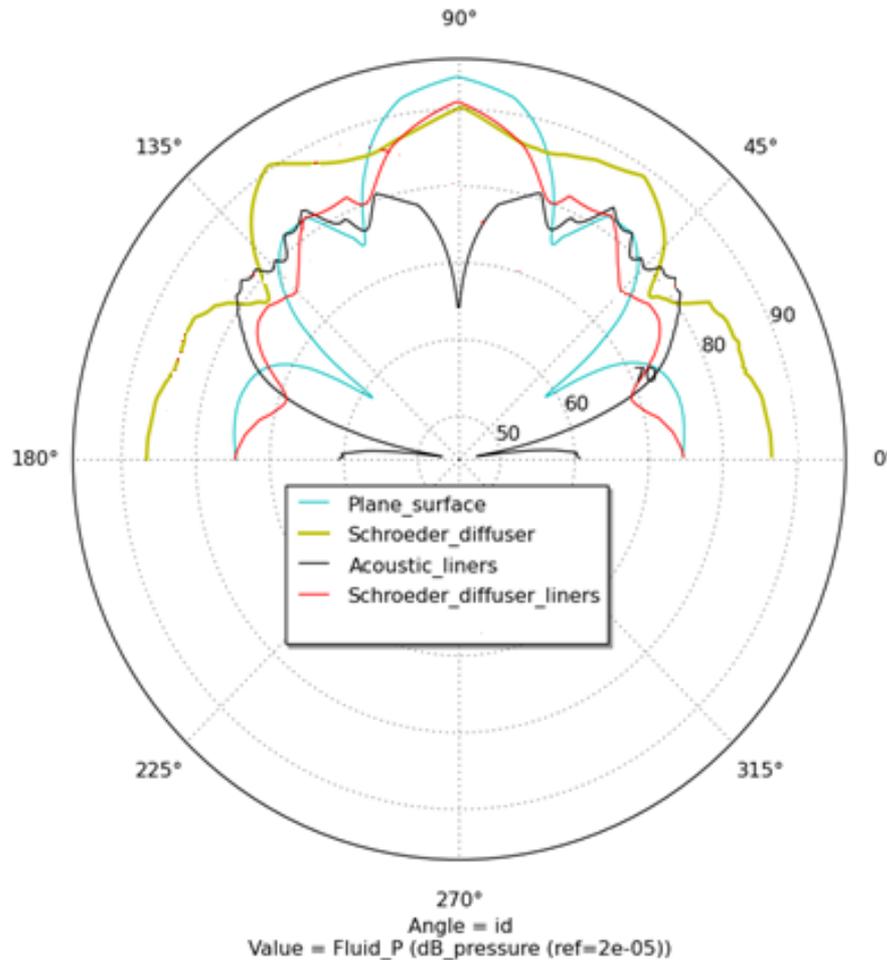


Fig.7- Directivity of various systems in noise reduction/scattering

5. Using of Schroder type advanced architecture design for plating of buildings around airports

- At present in the field of architecture, advanced Schroeder type materials are used for interior spaces (fig.8, [3]). These materials act as noise diffusers.

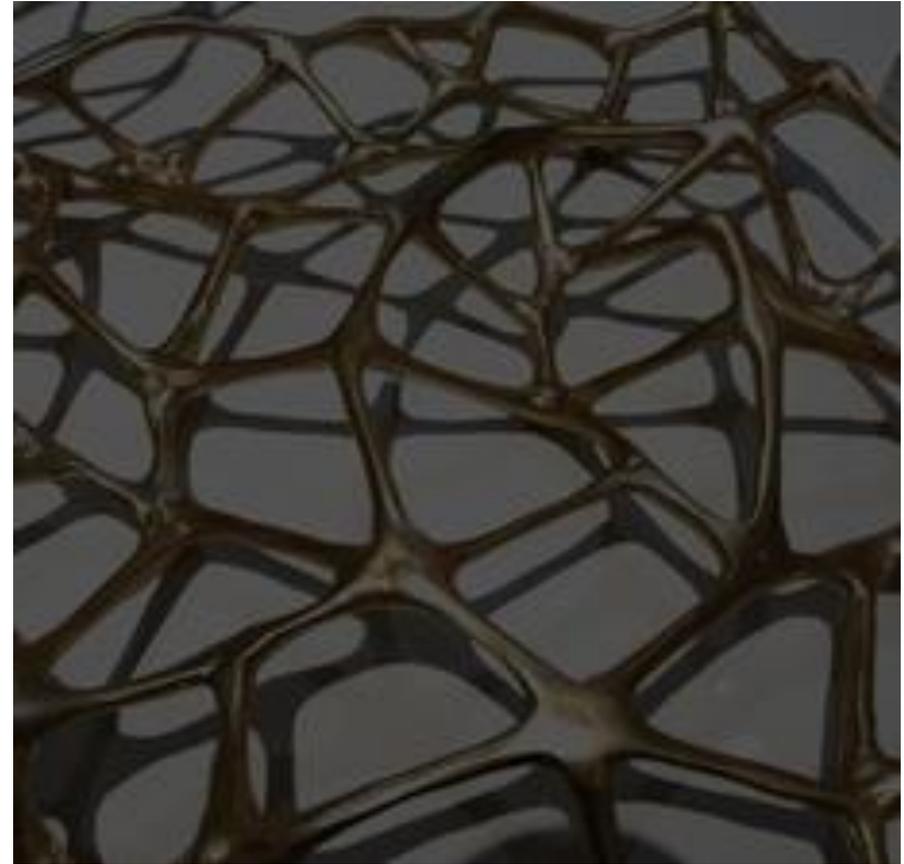
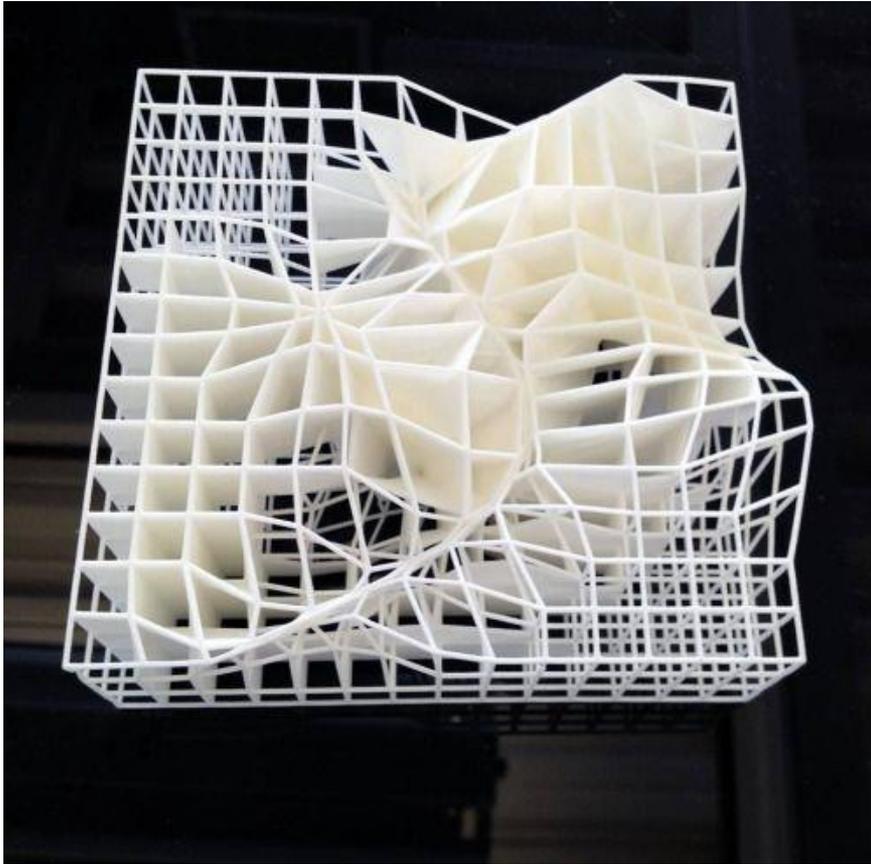


Fig.8- Various types of advanced Schroder type architecture materials [3]

5. Using of Schroeder type advanced architecture design for plating of buildings' exterior around airports

These structures could be applied in future especially for lining of buildings placed at small distance by airports (fig.9, [3]).

Advanced Schroeder type materials used for lining of buildings



Fig.9- Lining of buildings' exterior with Schroeder type structures for noise diffusing

6. Conclusions

- **Using of Schroeder type structures combined with perforated sheet placed on pressure side of wing, over engines, is a productive technology for noise reduction through reduction and scattering at source.**
- **Annoyance is reduced because the noise perceived at ground level by community is lowered through scattering on a larger area and because the distances of propagation to community increases .**
- **Lining the buildings' façades with Schroeder diffusers leads to noise diffusing and reduction of annoyance.**