

Chapter 6

Conclusions and Recommendations

“Nothing Lasts”

Mathew Sweet

6.1 Conclusions

Three numerical models have been developed in this thesis. These models provide valuable insight into the behavior of the weak radiating cell as a low frequency passive noise control approach. An analytical model of weak radiating cells applied as acoustical treatment to a simply supported beam was developed first. This model was then used to investigate the mechanical response of the WRC. The results of the model coupling effects showed the WRCs to have only a small influence on the treated beam response. The acoustic results when the WRCs' dipole frequency were set to occur near the first resonance of the beam-WRCs system, showed an overall sound attenuation of 9.8 dB. With a better understanding of the mechanical and acoustic responses of the WRC/beam system, parameters of the WRCs were modified to completely eliminate a single tonal disturbance of the radiating structure. Subsequent this investigation, attention was focused on reducing noise produced by the WRCs when operating at resonance. Two major topics were studied; *(i)* increase of damping (i.e., loss factors) to the spring elements of the weak radiating cells and *(ii)* intentional addition of perturbation to the operating resonances of the weak radiating cells. The results of the additional damping study showed that a maximum attenuated noise level of 20 dB in 0–251 Hz can be achieved with a 12 % loss factor. The second study, addition of perturbation to the WRC first resonance, indicated that an array of WRCs with mean resonance of 46 Hz and standard deviation of 3.16 have the ability to decrease noise levels by 19.7 dB in 0–251 Hz. Radiation efficiency and

wavenumber spectrum were also obtained that provided additional insight to the operation of the WRC/beam system.

To investigate a more realistic radiating system for analysis with the weak radiating cell as noise treatment, a model of a simple supported plate was developed. The plate parameters used for this investigation was similar to the experimental plate studied by Ross and Burdisso [27]. A comparison of both mechanical and acoustic responses from the model and the experimental results showed good agreement. Once the model was validated it was used to investigate the potential noise reduction capabilities. Noise attenuation levels near 15 dB for the 100–1600 Hz frequency range, which is 4.8 dB improvement over the noise reduction obtained experimentally, when the WRCs' plate surface area is increased by 6.7 % and a 4 % increase in the spring damping loss factor.

Lastly, a third model of the weak radiating cells applied as acoustic treatment to a 2D infinite plate was developed. The method used to develop this model provided closed form mathematical solutions for both the treated system response and acoustic field. The model also provided a simple means to illustrate the acoustic energy flow patterns. The ease of processing and ability to investigate only acoustic effects by this model is encouraging. The intensity vector plots at several key frequencies provided an excellent illustration of the fluid motion of a treated system.

6.2 Recommendations

Overall, several models have been developed that provide different approaches to study the behavior and acoustic properties of the weak radiating cell as a low frequency passive noise control device. With the development of these models and comparison to the experimental results provided by Ross and Burdisso [27] issues arise which present opportunity for improvement. Although the experimental investigation was not contributed by this work, the experimental results provided by Ross and Burdisso [26-27]

proved to be advantageous and it is suggested that the WRC acoustic treatment be investigate and tested on more realistic system. For example, the WRC should be tested to control interior noise in aircraft, rocket fairing, machine enclosures, and so forth.

It is also suggested that experimental work be put forth to studying the low frequency spectra in the region of the dipole frequency and WRC resonances. Very productive outcome and insightful knowledge could be gained from the improvement of the 2D infinite model. It's recommended that the fluid loading be included into the model. This will serve two purposes. Firstly, the asymptotes in the sound power spectrum will be eliminated and secondly the performance of the cell in heavy fluids can be investigated.

Lastly, introduction of active control to the WRCs to form hybrid cells could prove to be an effective approach to further improve the performance of this passive noise control device. For example, active control can suppress the resonance of the cell and reduce the increase of noise.

6.3 References

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