SILENCING THE HYDRAULIC JACKING AND LEVELING SYSTEM FOR NASA'S CRAWLER TRANSPORTERS

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The United Space Alliance (USA) sought outside assistance to evaluate and develop noise control measures for NASA's two crawler transporters located at the Kennedy Space Centre. Real time sound intensity measurements and sound pressure level measurements of a fully loaded crawler were taken with handheld measurement systems. The sound levels were analyzed and sound intensity mapping techniques used to determine the major noise sources on the crawler and the sound level contributions of the various noise sources. Conceptual noise control measures were then determined and presented. Based on the conceptual ideas detailed noise control measures were engineered based on achievable noise reduction targets. Upgraded engine exhaust silencers and ventilation fans and silencers have been installed on both crawler transporters as the first phase of the noise control measures. A prototype inline hydraulic silencer for the jacking and leveling hydraulic system was designed and tested. The results of the prototype testing indicated that a significant reduction of the hydraulic system noise could be achieved. Hydraulic silencers based on the prototype design have been manufactured and are now installed on one of the crawler transporters along with resilient hydraulic line and hydraulic pump mounts as the next phase of noise control measures. Before and after sound level measurements indicate that noise reductions of 3 to 15 dBA have been achieved with the installation of the hydraulic system noise control measures

A STUDY OF LOW-NOISE PAVEMENTS FOR THE ALBERTA CLIMATE: PRELIMINARY RESULTS

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There have been intense efforts to develop paving materials which will reduce the noise from road traffic, specifically from the tire-road interaction. Many of the pavement types which have been developed use a porous asphalt surface to reduce the noise from the air trapped within the treads of the tires, among other factors. The performance and the surface of previously developed pavement types have been difficult to maintain in the Alberta climate.

The City of Edmonton and the City of Calgary have been active in developing new asphalt mixes for this noise reduction. These use recycled rubber to increase the flexibility of the pavement and improve the durability, and in this process uses up the surplus supply of discarded tires.

Studies have commenced in Calgary on some rubberized asphalt mixes (designated “ARHM” for “Asphalt, Rubberized - Hot Mix”), where the rubberized asphalt is used as a final topping (or “Top Lift”) of the road surface.

For one section of Crowchild Trail, measurements were taken before the top lift was applied and within two weeks of its application. Along 17th Avenue SW, two different mixes were applied, and measurements were made within two weeks of the application of the “dry process” mix.

Further measurements are to be made in spring, when the materials have presumably survived on Calgary winter.

ACOUSTICAL LAGGING AND ACOUSTICAL BLANKETS: DESIGNS FOR HIGHER INSERTION LOSS

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Acoustical lagging and acoustical blankets are practical and effective noise control treatments frequently used in industrial facilities. Acoustical lagging is a permanent, close-fitting, noise reduction wrap that is fastened directly to a noise-radiating surface, such as a pipe or vessel. Acoustical blankets are also close-fitting, noise reduction wraps, but are designed to be removable, allowing access to the underlying equipment. Examples of equipment where acoustical blankets may be used are steam turbines, compressors, flanges and gearboxes. The fundamental design for acoustical lagging and blankets is an inner layer of sound absorptive material combined with an outer layer of sound barrier material. For increased insertion loss, a four-layer system comprised of alternating layers of sound absorptive and sound barrier materials is typically used. The noise reduction performance of acoustical lagging and blankets is best at frequencies above 1 kHz, where insertion losses ranging from about 20 dB to more than 40 dB can be obtained. Below 1 kHz insertion losses diminish rapidly with frequency; acoustical lagging and blankets are not effective for low frequency noise reduction. Since acoustical lagging and blankets are very practical treatments for industrial applications, extending the performance capabilities can be an attractive alternative for "difficult" noise sources amenable to lagging and blankets. This paper describes two case studies where enhanced acoustical lagging and blanket designs were developed and used to provide noise reductions significantly greater than possible with typical acoustical lagging and blankets.

Selective attenuation of 3- short parallel barriers in an exponentially-ordered two-dimensional space

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Through mathematical modeling, the positioning of a series of short parallel barriers, with logarithmically-ordered dimensions, in the path of a sound source and a receptor results in a phenomenal noise reduction at selected frequencies. Guided by the laboratory "selective attenuation" results obtained by acoustical research on seat-dip phenomenon in auditoria, and using a novel logarithmic and exponential rules to formulate relations between source-barrier-receiver dimensions and distances, a series of three parallel barriers represented by a 10th scale model was constructed and modeled utilizing the Boundary Element Method - the Helmholtz-Kirchhoff Integral Equation and its derivatives - along with the CHIEF's method to confirm the Non-Unique solutions of Schenck. Following sign conventions of Morse and Ingard, attenuation of critical frequencies between 50 Hz and 500 Hz were investigated. For each frequency, a number of vertices and elements were calculated, and results were obtained. A selective attenuation of 38 dB is observed at the frequency 200 Hz. This selective attenuation does not agree with the conventional understanding. The conclusion is that a logarithmic arrangement of dimensions in the two-dimensional space was the cause of this phenomenon and this may be related to the inherent physical nature of sound, its propagation, diffraction and interference.

ACOUSTIC PERFORMANCE OF ARBITRARILY SHAPED BARRIERS

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Barriers, or acoustic shields are used frequently as noise control devices. Despite this, the formalisms used to predict their performance range from correlations established from model experiments (Maekawa) to models based on ray-acoustics. The former has obvious limitations with regard to finite barriers, or barriers of arbitrary shape. As the underlying physical process of 'shielding' is diffraction, the use of ray-acoustics is not really all that appropriate. The above schemes, as well as analysis, both exact and approximate, tend to focus on the shortest diffracted path, which can be expressed in terms of the Fresnel Number. One of the approximate methods, the Maggi-Rubinovitz formalism, uses a line integral along the diffraction edge. The accuracy of the predictions is significantly improved, if an ad-hoc correction term, is incorporated in the line integral.
The prerequisite integrals can be performed numerically. This then allows one to estimate the barrier attenuation afforded by barriers of arbitrary shape, or multiple barriers. The predictions are supported by scale model testing.

The Fiber Vibration Sound Absorption Theory

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Fibrous materials had been used as sound absorption materials for over one century .The current sound absorption theory is still the Rayleigh model. But it not agrees with the practice even though it had been studied for over 100 years. Based of Rayleigh model, Zwikker and Kosten established the theory of acoustical effective density and the effective bulk modulus, which is also the popular theory in acoustics literature to explain the sound absorption characteristics of fibrous materials. However, because of the complexity of these expressions, it is difficult to obtain physical insight into the acoustic behavior of the porous materials and to determine the dominant mechanism for sound absorption for a given material at a given frequency. Alternatively there are very simple expressions.

A new theory was put forward that fibrous material absorb the sound by the fiber layer's vibration. The vibration analyzing and the comparing of testing results and theory results have justified this theory. It is also supported by the empirical sound absorption formula of fibrous material in another paper of the author.

THE STACK INDUCED DRAFT AERIAL COOLER

(SIDAC)

By

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This paper examines the application, operation and economics of fanless, noiseless aerial coolers to the Oil and Gas industry in areas where process cooling is required in noise sensitive areas or in areas where no electrical power is available to drive conventional cooler fans.

Aerial cooler fans have long been the subject of various ideas for noise control – cooler silencers and low noise fans being the primary target for acoustical engineering. During his time with Amoco, Nev Hircock first designed and tested two SIDAC units for process cooling. Due to the capital expense and plot plan requirements this idea, though technically proven, remained largely dormant. However given today's stricter noise control, today's higher electrical costs and today's focus on reduced emissions; this technology which produces zero noise, zero operating costs and zero emissions, is due for re-examination.

INTEGRATION OF NOISE CONTROL INTO THE PRODUCT DESIGN PROCESS: A CASE STUDY – THE SILENT AIRCRAFT INITIATIVE

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The Silent Aircraft Initiative is a joint University of Cambridge – Massachusetts Institute of Technology (MIT) and industry design collaboration with the aim of designing a commercial aircraft with noise emissions that would barely be heard above the background noise level in a typical urban built-up area. In this paper the Silent Aircraft Initiative will be used as an illustrative case study on the benefit of integrating noise control as a key component of the design space during product development, rather than as an after-thought.