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Noise Control by Structure and Material

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EGN 402: Senior Design Project

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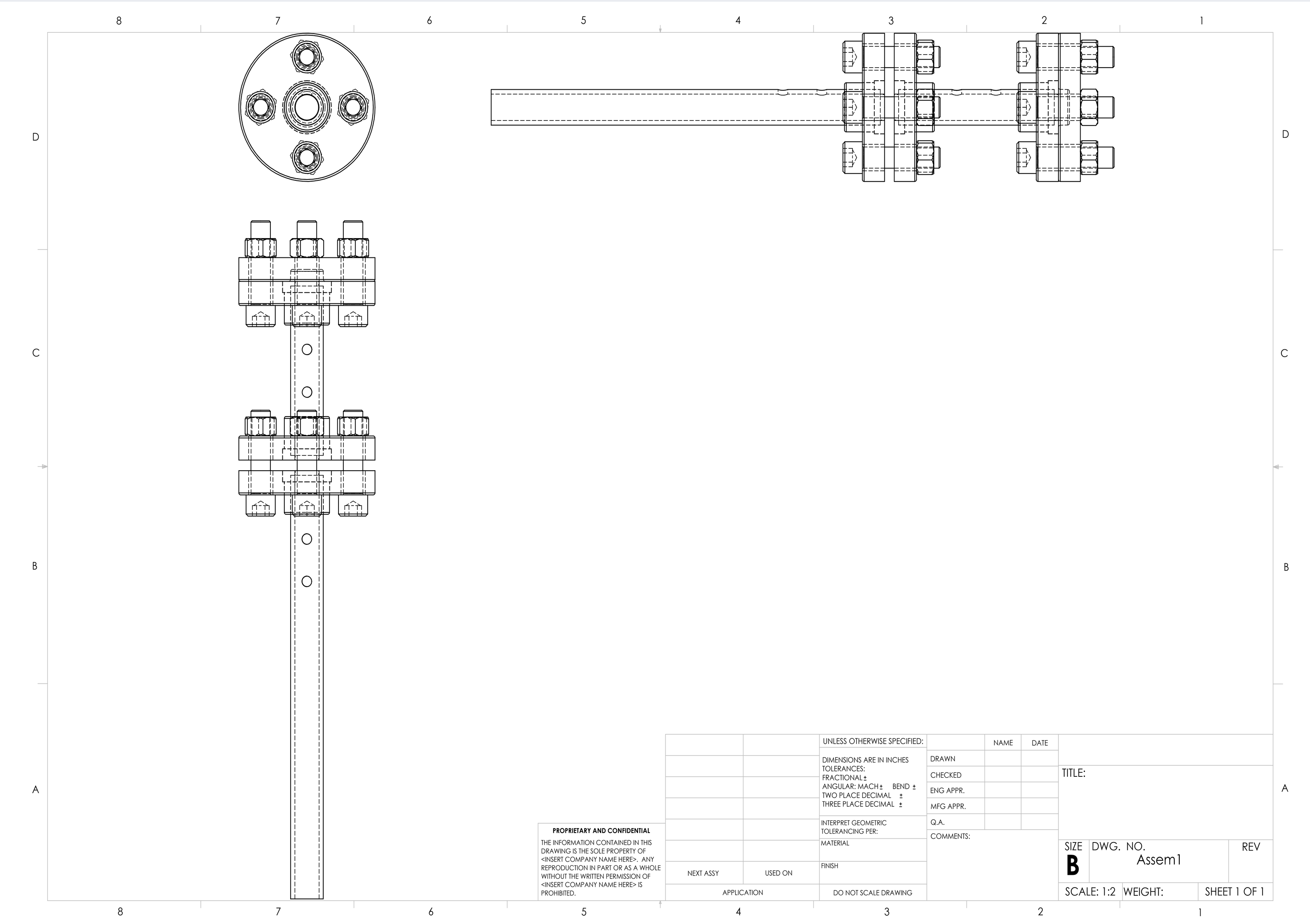
Engineering Drawing



Testing Apparatus and Equipment

The testing apparatus seen in the engineering drawing and CAD model is designed to follow ASTM E1050 standards. The important details specified by the standard that are seen in the design include massive and rigid flanges, massive and rigid termination, smooth tube surfaces, and access for two microphones on either side of the sample. Modifications were made from this model to the actual apparatus to suit the needs of the testing as well as fit to a realistic budget. These modifications include: sound insulating foam was used at each microphone hole to reduce outside noise and to hold the microphones flush with the inner surface of the tube, two microphones were used rather than four to fit the budget better, and the final end cap was replaced with a solid block of wood to create a stand structure for the apparatus.

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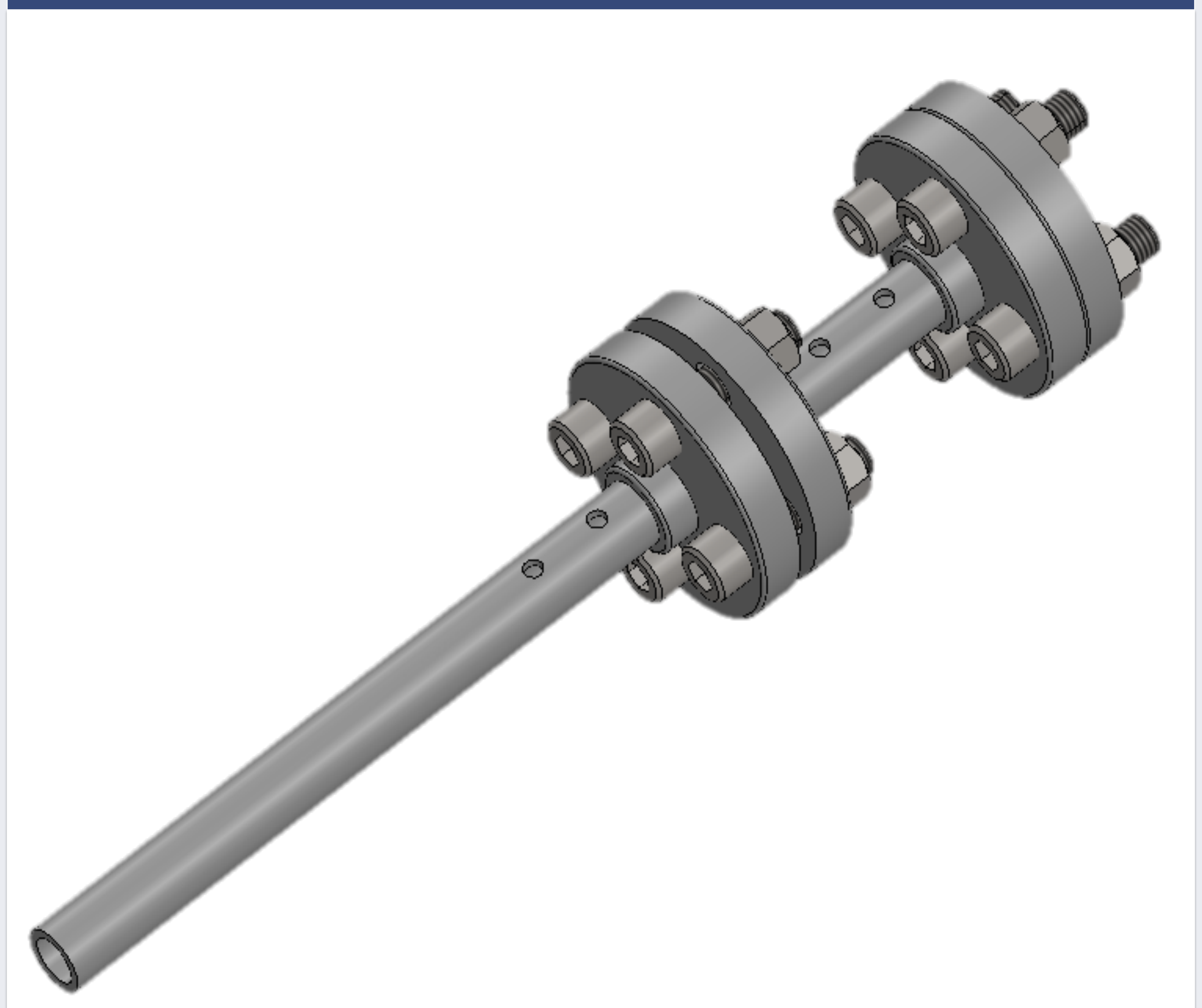
Other equipment was used for data recording, sound production, and data processing. A capsule enclosing a speaker was created to produce the sound at the open end of the tube while also terminating any sound the extended beyond the diameter of the tube. Two lab grade microphones were used for data recording, which required custom wiring and a USB sound card. Mathematica software was used to help streamline data production, processing, and organization. Audacity software was used to simultaneously play the input sound and collect sound data from the microphones.

Abstract

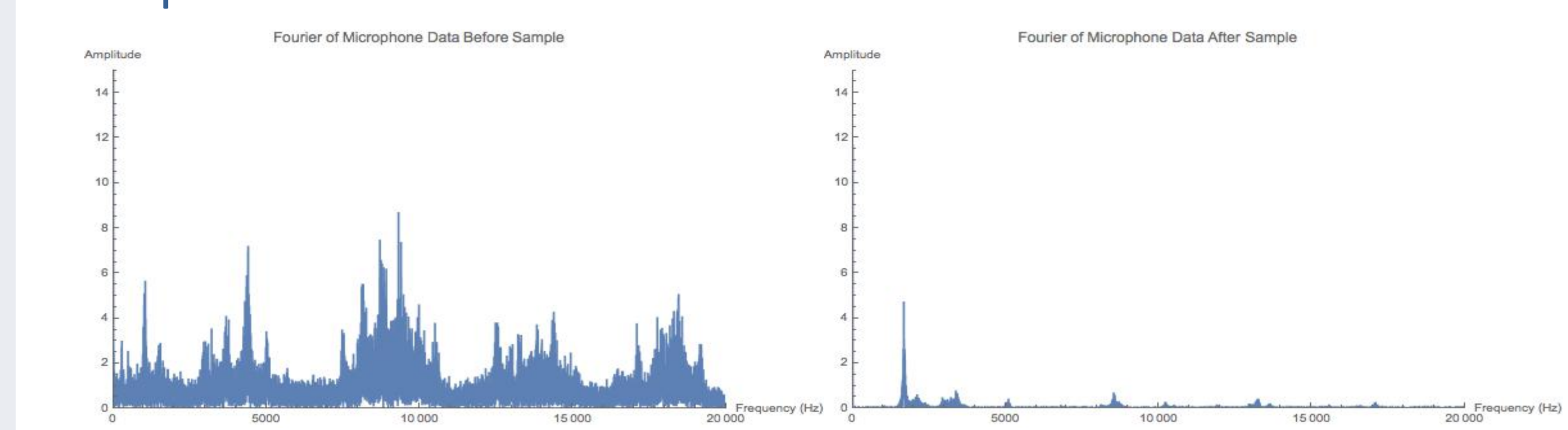
An acoustic impedance testing tube is designed and constructed to test noise absorption properties of selected materials. The structure will be made to be convenient for demonstration purposes and real testing procedures while following ASTM E1050 standards as closely as possible. An engineering drawing as well as a 3D-CAD model of the structure is developed. Testing is conducted on selected materials; mainly ones that will allow obtained results to be compared to results found by other parties. Various sounds will be generated using Mathematica programming; the types of sound will include single frequency, wide band and narrow band noises. Microphones are used, in conjunction with an oscilloscope or computer, to analyze the sound received on either side of the material in the tube. Through data processing various operations and Fourier transforms are performed on the collected sound data. This processing allows for unique characteristics of the materials to be extracted from the data. This data relates the damping effects of the material as they relate to the power and frequency of the noise. The properties of the materials are compared to published material properties. Based on the results, suggestions and ideas for further testing or redesign are reported. Parts that are used or are to be recommended for use are listed.

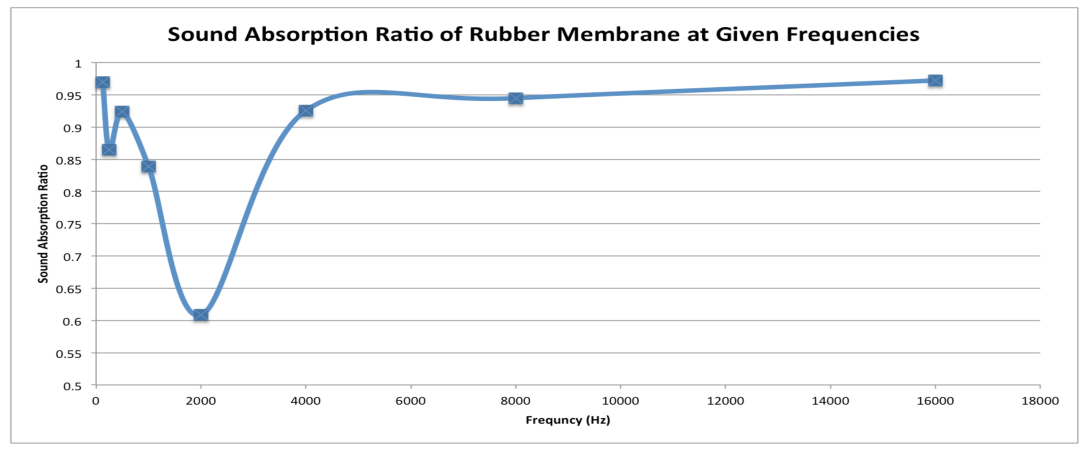
3D CAD Model



Example of Results

Two types of results should be produced for each material sample. First they are all tested using a single broad band white noise input signal. The Fourier transform of the signal from each microphone is calculated and presented against each other to observe changes in amplitude in the frequency domain before and after the sample. Then selected single frequency signals are used pinpoint the samples damping effectiveness at those preselected frequencies. Rubber Membrane is used as an example below.





Test Sounds and Test Materials

Three types of sounds were used to test the characteristics of the materials. **Single Frequency** sound signals oscillate at only one frequency (signals at 125 Hz, 250 Hz, 500 Hz, 1,000 Hz, 2,000 Hz, 4,000 Hz, 8,000 Hz, and 16,000 Hz were used in testing). **Broad Band Noise** is sound signal with random frequencies that vary greatly. **Narrow Band Noise** is a sound signal with random frequencies specified by a narrow range of frequencies. A broad band white noise was used to test each material.

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The materials tested were intended to test varying degrees of permeability and abundance of "imperfections and also materials that are commonly used for sound blocking. They range from solid rubber membrane (with the least permeability and lest imperfections) to low density aluminum foam (with high permeability and a very random structure). The samples include **rubber membrane, closed cell poly foam, open cell poly foam, felt, low density aluminum foam, high density aluminum foam, high density fiberglass insulation, low density fiberglass insulation.**