IENG 464: Senior Design II

Rapid City Public Library - Noise Mitigation

Proposed Solutions

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Method: Acoustic Panels along Wall above Floor Cavity
Noise Reduction Coefficient: 0.82
Expected dB Change: -15 dB
Material Cost: $286.95 x 3
Cost/Expected dB Change: $57.39/-1dB

Description:

Installing acoustic panels above the floor cavity between the first and second floor of the library, can significantly improve the acoustics of the space by reducing unwanted noise and creating a more pleasant listening environment. The purpose of these panels is to reduce noise transmission and intercept sound waves that travel along the convex corridor.

The acoustic panels can be made of various materials, such as fiberglass, mineral wool, or foam, that have a high noise reduction coefficient (NRC) and can absorb sound waves effectively. The panels are typically installed in a grid pattern or evenly along an open wall.

Link to Product:
https://www.acoustimac.com/acoustic-panels/acoustic-panels-dmd-series/xl-acoustic-panel-842

Reference:
https://blog.thermaxxjackets.com/decibel-drop-noise-reduction-coefficients-for-material-combinations

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Method: Covering Cavity with Fabric

Noise Reduction Coefficient: 0.95
Expected dB Change: -26 dB
Material Cost: $108.19 x 4
Cost/Expected dB Change: $16.6/-1 dB

Description:

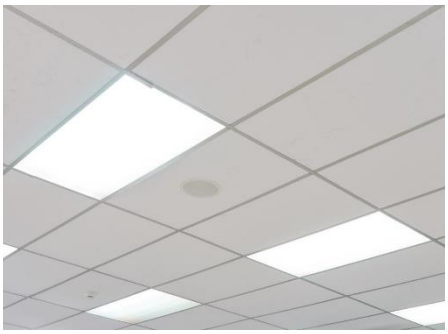
Covering the floor cavity with a sound-absorbing fabric can significantly contribute to noise mitigation. The fabric acts as a barrier that traps and absorbs sound waves, preventing them from bouncing off hard surfaces and creating echoes or reverberation. This will reduce the overall level of noise in the environment. The fabric's fibrous texture and composition provide excellent sound absorption properties, allowing it to effectively attenuate a wide range of frequencies, from low to high, including regular chatter, book cart noise, and entry/exit noise.

When installed tightly and correctly, the fabric can act as an additional layer of insulation that prevents sound from passing through the opening of the floor cavity. This can be particularly beneficial in the library setting. By adding a sound-absorbing fabric to the floor cavity, the fabric can help to break the path of sound transmission that passes through to the top and bottom floor, thereby mitigating the impact of noise pollution and improving the overall acoustic setting.

Link to Product:
https://vocalboothtogo.com/product/studio-size-black-producers-choice-acoustic-blanket-vb77g-10ft/

Reference:
https://vocalboothtogo.com/producers-choice-blankets-2/

Method: Drop Ceiling in Community Conference Room to Complete Roof



Expected dB Change: -22 dB
Material Cost: ~ $3,064
Cost/Expected dB Change: $139/-1 dB

Description:

A drop ceiling, also known as a suspended ceiling, is a secondary ceiling that is installed below the main structural ceiling. It consists of a grid of metal channels that are suspended from the main ceiling using wires, and tiles or panels that fit into the grid.

One of the primary benefits of a drop ceiling is its ability to reduce noise levels in a room and also reduce sound levels leaving the room. This is because the tiles or panels used in the ceiling act as a barrier that absorbs sound waves, preventing them from bouncing around the room and causing echoes or reverberation.

This method would be beneficial to the Rapid City Public Library, because it would complete the roof that is missing within the Community Conference Room, trapping sound coming from inside of the room, as well as block noise from outside.

Link to Product:
https://www.soundacousticsolutions.com/product/white-acoustic-ceiling-tiles/

Reference:
https://www.angi.com/articles/how-much-does-it-cost-install-drop-ceiling.htm

Method: Active Noise Mitigation System (Upgrade or New Installation)

Expected dB Change: 25 dB - 35 dB
Installation Cost: $6,351
Cost/Expected dB Change: $211.7/-1 dB

Description:

Sound masking systems generate a soft, subtle background ambient sound, similar to airflow, through specially-designed loudspeakers hidden throughout the space. The workspace's soundscape becomes more uniform, more relaxing, and noisy distractions are effectively muffled out, providing occupants with a greater sense of acoustic privacy.

Not much is known about the Active Noise Mitigation system currently in place within the library. More research into this system should be looked into, as it could greatly reduce the cost of replacing it with a completely different system.

Upgrading, fixing, or installing a brand new system would greatly benefit the library as it would heavily reduce the amount of sound on the second level.

Link to Product:
https://www.softdb.com/sound-masking/

Reference:
https://www.telco-data.com/sound-masking-systems-cost/

Method: Second Floor Library Layout Change

Expected dB Change: 25 dB - 40 dB
Material Cost: $$$

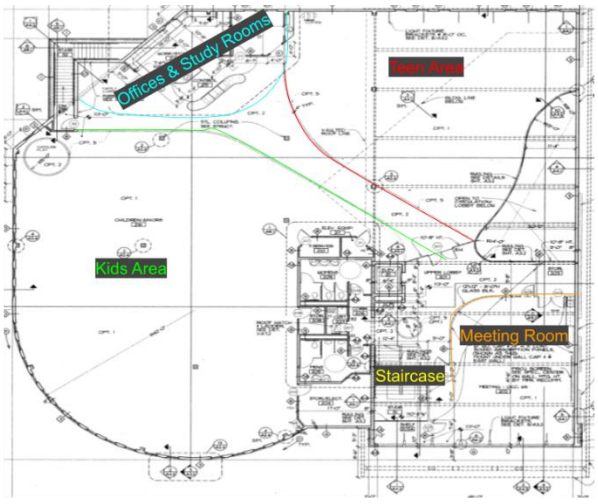
Description:

The two figures down below showcase the current layout as well as the proposed layout. The main component of the proposed change is to move the Community Meeting Room to the other side of the second floor of the library. This will completely eliminate sound waves leaving the meeting room and traveling along the convex corridor, as well as traveling between the first and second floor cavity.

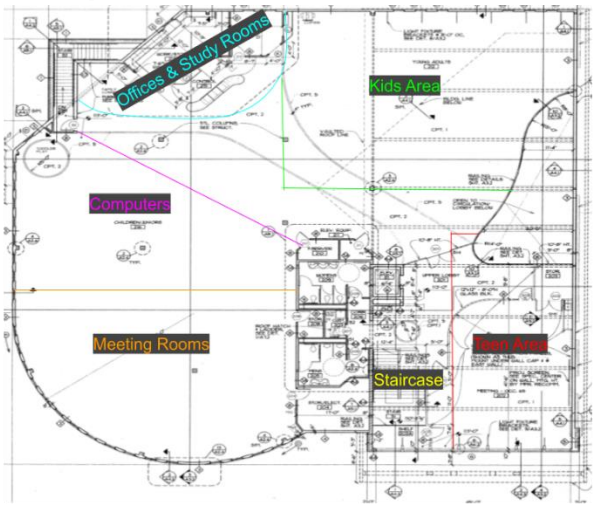
These changes will greatly affect the way noise works on the second floor of the library, nearly eliminating the problems that are caused by the current position of the meeting room.

If the layout is changed, safety precautions such as fire egress from the room, will need to be acknowledged.

Current Layout:



Proposed Layout:



Equation used for expected decibel drop:

$$d = -20 \log_{10}(1 - c)$$

Where:

d = decibel drop

c = Noise Reduction Coefficient (NRC)