Building America Case Study

Predicting Envelope Leakage in Attached Dwellings

PROJECT INFORMATION

Project Name: Predicting Envelope Leakage in Attached Dwellings

Consortium for Advanced Residential Buildings, *carb-swa.com*

Building Component: Building envelope

Application: New and retrofit; multifamily

Year Tested: 2013

Applicable Climate Zone(s): All

POTENTIAL BENEFITS OF MODEL

Requires substantially fewer resources in the field—equipment, personnel, and time, because only solo test values are needed.

Does not require simultaneous access to multiple housing units, which is extremely difficult in occupied housing.

Provides a more appropriate approximation of thermal envelope leakage and the potential energy benefits of air sealing.

The most common method of measuring air leakage is to perform a single (or solo) blower door pressurization or depressurization test, or both. In detached housing, the single blower door test measures leakage to the outside. In attached housing, however, this solo test method measures air leakage to the outside and between adjacent units through common surfaces. Although minimizing leakage to neighboring units is highly recommended to avoid indoor air quality issues, reduce pressure differentials between units, and control stack effect, the energy benefits of air sealing can be significantly overpredicted if the solo air leakage number is used in the energy analysis.

Guarded blower door testing is more appropriate for isolating and measuring leakage to the outside in attached housing. This method uses multiple blower doors to depressurize adjacent spaces to the same level as the unit being tested. A neutral pressure across common walls, ceilings, and floors guards against air leakage between units. The resulting measured air leakage in the test unit is only to the outside. Although preferred for assessing energy impacts, the challenges of performing guarded testing can be daunting.

In an attempt to create a simplified tool for predicting leakage to the outside, the U.S. Department of Energy Building America team, Consortium for Advanced Residential Buildings (CARB), performed statistical analysis on blower door test results from 236 attached dwelling units in 17 apartment complexes. The correlation between building specifications and the ratio of guarded and solo test results was investigated. Although the subject data were limited in quantity and variety, the analyses suggest significant predictors are present and support the creation of a predictive model.

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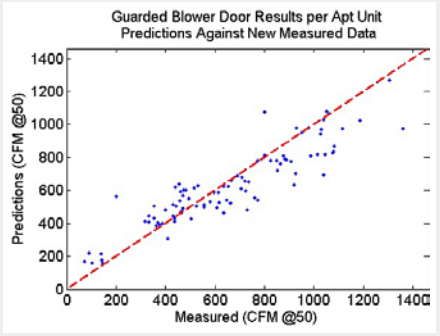
Guarded blower door setup: Conducting a guarded blower door test for these row houses required three blower doors working simultaneously and four people—three to operate the equipment and one to coordinate the effort. With other unit configurations such as stacked apartments, a fully guarded test could easily require three to six times the equipment and labor.



This graph of the model results shows predicted against measured guarded blower door value. The predicted values were obtained by multiplying the measured unguarded blower door values by the predicted ratio of guarded to unguarded blower door values. The diagonal red line represents an accurate predictive model. The closer the data points are to the red line, the more accurate the model.

For more Information, see *Multifamily Envelope Leakage Model* at: *buildingamerica.gov*

Image credit: All images were created by the CARB team.

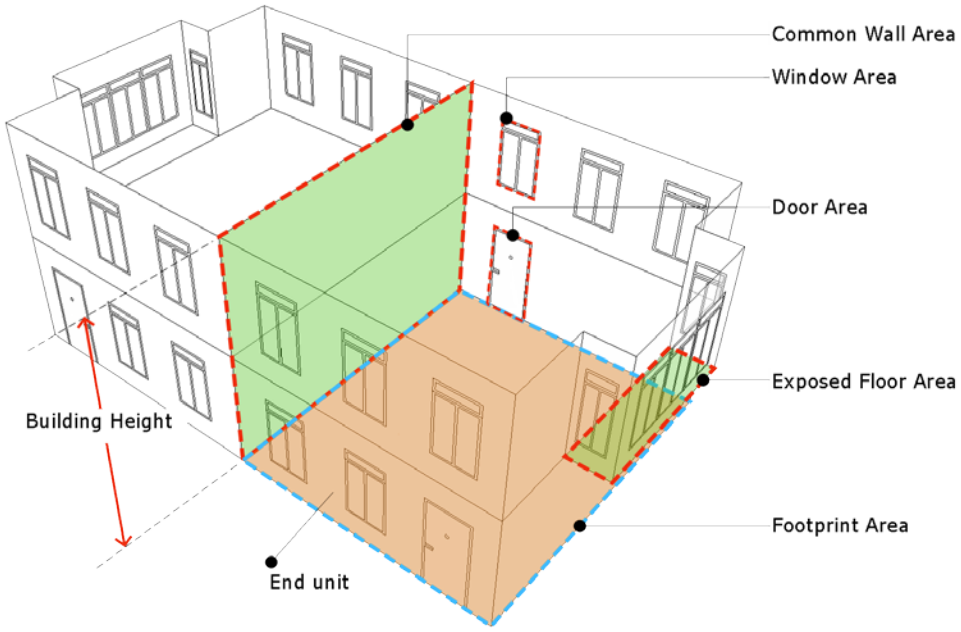


Illustration of typical building specifications evaluated in the model.

Description of Model

A multivariable linear regression was selected as the form for the model. The intended result is a simple and reusable tool for builders, raters, engineers, and architects to predict air leakage to the outside based on a solo blower door test value and a few significant building specifications (predictor variables).

Predictor Variables

- Door area describes the area of the door.
- Shared surface area describes the total surface area shared between units, including walls and ceiling.
- Envelope perimeter describes the sum of the lengths of all edges of a unit.
- Age describes the age of the unit.
- Duct location indicates whether a unit has ductwork and if so, whether it is in conditioned or unconditioned space.
- Climate zone indicates which climate zone a unit is in: 3A, 4A, 5A and 6A.

The root mean square error of the model was 0.13. It measures how far the predicted values are from measured values. A coefficient of variation of root mean square error of 19.6% was obtained when the model was used to predict fully guarded values from test data. A test of the model on data for 14 apartments in two buildings showed accuracy within ± 13.2%.

Looking Ahead

The next step is to work with groups such as the Residential Energy Services Network, the Building Performance Institute, and utility program administrators to further validate and use the model.

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

For more information, visit:
buildingamerica.gov

The U.S. Department of Energy's Building America program is engineering the American home for energy performance, durability, quality, affordability, and comfort.

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