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Instrumentation and Measurement of Airflow and Temperature in Attics Fitted with Ridge and Soffit Vents

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ABSTRACT

This study established a research facility where airflow velocities, temperature, and differential pressures could be measured at the ridge of an attic. Following the construction of a test building, sensors were constructed, calibrated, and installed inside the attic. Paired tests were performed for three different ridge vent treatments; two were rolled type vents and one was a baffled vent. When both attics were fitted with the same ridge vent, the airspeed and differential pressure profiles at the ridge were very similar for both attics, indicating that any observed differences in airspeed and differential pressure were caused by the ridge vent treatment used. The baffled vent and rolled vents were then installed on the ridge of the west and east attics, respectively.

The data demonstrated that the baffled ridge vent provided a minimum of twice the ridge airspeed of the rolled vents, when all wind conditions were considered. On the day selected to study the direction of the airflows at the ridge, the baffled vent had airflow speeds at the ridge similar to the rolled vent without fabric backing. The baffled vent allowed air to come out of the attic through both sides of the ridge (negative differential pressures on both sides), while the rolled vent without fabric backing caused air to enter through the south side of the ridge and exit through the north side (positive differential pressure on the south side and negative differential pressure on the north), in effect short-circuiting the vent. The fabric-backed rolled vent allowed attic air to come out of the attic through both sides of the ridge, as did the baffled vent, but the airspeed was slower. The baffled vent was the one with the highest airspeed at the ridge and also had both sides of the vent under negative differential pressure, providing the most effective ventilation.

INTRODUCTION

When analyzing the efficiency of new construction practices, engineers are usually concerned with parameters such as temperature, moisture, airflow, and energy consumption. Rarely does attic design take into account the effect of such parameters on household insect pests, such as German cockroaches or periodomestic species of cockroaches (those living "around" the domestic environment but not necessarily in it), which invade both attic spaces and living quarters (Brenner and Patterson 1988). Chapman (1969) reported that environmental humidity and temperature are of great importance with regard to insect survival. Metabolic rate and insect activity both increase with temperature until a level is reached at which the insect becomes immobile and finally dies. For short periods of exposure, insects can withstand higher temperatures if the air is dry because they are cooled by evaporation. For long-term exposure, low humidities cause insect death from desiccation.

Studies show that 10 to 15 million Americans are allergic to cockroaches. In practice, the more airtight and energy efficient a structure is, the greater the incidence of insect allergy. Allergic reactions range from a runny nose to severe asthma attacks and even death (Silva 1990). Studies have shown that airtight construction produces increased levels of cockroach allergen (Barnes and Brenner 1996). Consequently, preventive measures designed to reduce or eliminate the infestation would result in both a reduction in pest numbers and a reduction in their attendant allergens.

Research has shown that some of the parameters that favor cockroach survival include high humidity and an environment where there is either a constant low airflow or no airflow, with the latter preferred. This environment is found in the attics of many underventilated homes. Brenner (1991) performed a study in a building with paired attics in which ridge and soffit ventilation was used. After a two-month

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period of acclimatization in which equal numbers of cockroaches were observed in both attics, the ridge and soffit system of one attic was sealed. Humidity profiles in the unventilated attic changed considerably and closely resembled those found in a tree hole, which was monitored concurrently. At the end of a two-week period, most of the cockroaches in the ventilated attic had moved to the unventilated attic and this trend continued for the duration of the test. The lack of detailed investigations in this area prompted the design of a facility where the complex interaction between all the parameters affecting periodomestic cockroach survival in an attic could be studied. Therefore, reducing the humidity of the attic space and enhancing its airflow rate may greatly reduce the probability of infestation of cockroaches without the use of pesticides.

Moisture, temperature, and airflow in attic spaces are important parameters, not only for cockroach survival, but also in building envelope design with energy-efficiency considerations. An attic can be modeled as a container in which air flows in and out. To remove the greatest amount of thermal energy trapped in the attic, one should introduce cold air into the bottom of the attic and exhaust hot air from the top. To minimize the heat flow downward through the ceiling, thermal stratification in the attic air space should be maintained at a maximum, keeping the cooler air closer to the surface of the ceiling insulation and the warmest air closest to the ridge. The inlets preferably are located low in the attic, as in the case of soffit vents, and the outlets are located at the peak of the attic, as would be the case for ridge vents. Ventilating airflows running along the ridge from gable to gable cause the attic air to be well mixed Fairey et al. (1988). The trusses themselves behave as obstructions, diverting hotter air closer to the insulation and causing a higher heat flow through the ceiling insulation into the conditioned space. In contrast, ventilating airflows from soffits to ridge minimize the disturbance in the airflow. The airflow will then act in conjunction with natural thermal buoyancy forces to help ventilate the attic. Parker et al. (1991) made extensive measurements to validate their model of attic thermal performance. Statistical data analysis showed that wind speed was the primary driver of attic ventilation, with thermal buoyancy being a significant but secondary factor. On calm days, thermal buoyancy in attics can provide the majority of the attic's ventilation (Fairey et al. 1988). Studies have suggested that attic thermal conditions are of primary concern to air-conditioning demand when the supply ducts are located in the attic space (Parker 1990).

There is controversy over the issue of whether or not venting the attic space reduces the temperature of the shingles and sheathing, thereby prolonging their life, and whether damaging moisture in an attic can be effectively removed by the increased airflow of a ventilated attic (Gu et al. 1993). Rose (1992) showed that when ventilated and unventilated attics were exposed to the same field conditions, ventilation kept the attic cooler and the reduced attic temperature had a cooling effect on the sheathing. TenWolde and Carll (1992) investigated the effect of airtightness and vents on moisture and airflow in walls and attics for cold winter conditions. In their opinion, vents did not deliver enough air movement for drying and could, in fact, cause more wetting. For cathedral ceilings and flat roofs, they suggested it would be preferable to fill the entire attic cavity with insulation.

OBJECTIVES OF STUDY

The purposes of this study were (1) to develop, calibrate, and deploy instrumentation suitable for attic microclimatic measurements; (2) to determine if the attics tested behaved similarly under identical ventilation treatments; and (3) to evaluate several ventilation systems presumed to provide adequate ventilation and select the one that provides the highest ventilation rate, a parameter that will affect both the temperature and the moisture levels in the attic. It is expected that this study will establish a database from which the optimal combination of airflow and temperature can be obtained to minimize pest survival and maximize energy efficiency.

The combination of ridge and soffit vents provides the most consistent and balanced ventilation to an attic (Wolfert 1987). A variety of ridge vents are available, and not all of them can be expected to provide the same level of ventilation. Once the facility and instrumentation are characterized, the effect of passively varying the attic microclimate on pest survival can be studied.

This paper is part of a larger continuing research effort directed at developing nonchemical strategies for pest control.

EXPERIMENTAL BUILDING

A structure measuring 26 ft by 40 ft (7.9 m by 12.2 m) with the ridge oriented along an east-west axis (Figure 1) was specifically designed for pesticide and allergen studies in Gainesville, Florida. The foundation was a monolithic concrete slab and the roof pitch was 6:12 with gable ends and 2 ft (0.6 m) overhanging soffits. The exterior siding consisted of T-111 with R-11 unfaced fiberglass insulation filling the wall voids. The roof was covered with light-colored, triple tab dimensional asphalt shingles. The sides of the structure were made with a metal frame so that all the walls could be removed and replaced after pesticides are tested. The attic itself was not meant for pesticide testing; it was made of standard flat ceiling, truss-framed wood construction.

As seen in Figure 1, the attic of the research building consisted of two identical chambers 26 ft (7.9 m) wide by 18 ft (5.5 m) long. The two chambers were separated by a 26 ft by 4 ft (7.9 m by 1.2 m) center chamber that provided space for instrumentation and the electrical box for the building. To prevent temperature-induced zero drift in the instrumentation, this chamber was insulated with 1 in. (2.54 mm) of rigid insulation and air conditioned. In this paper the two 26 ft by 18 ft (7.9 m by 5.5 m) chambers will be referred to as the attics. Each attic had an 8 ft (2.4 m) catwalk that extended the entire 18 ft (5.5 m) length of the attic. Catwalks were constructed in four hinged sections from nominal 2×4 in.

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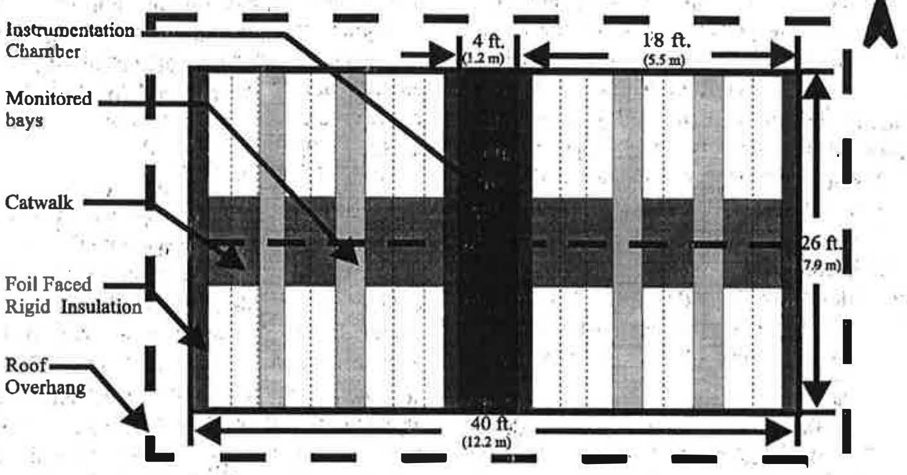

Figure 1 *Plan of the research building.*

(50.8 × 101.6 mm) boards with 1.5 in. (38.1 mm) spaces between the boards and remained in the downward position throughout the test. The sections were elevated on nominal 2 × 6 in. (50.8 × 152.4 mm) boards to provide sufficient space to accommodate the loose fill R-30 blown-in insulation. The hinged catwalk sections allowed access to the ridge instrumentation without disturbing the insulation. For the purpose of this test, the attics were considered as having no gables. Both gables of each attic were covered with 1 in. (25.4 mm) of foil-faced rigid insulation (refer to Figure 1). In addition to gable end insulation, each attic was thermally isolated from the other by the instrumentation chamber that separated them.

The literature clearly indicates that the most effective form of attic ventilation is a combination of ridge and soffit vents (Fairey et al. 1988; Wolfert 1987), and these were used exclusively in this structure. The soffit ventilation consists of a 2 in. (50.8 mm) strip vent installed 4 in. (101.6 mm) from the fascia running the full length of the north and south soffits and providing 2.25 ft^2 of free vent area. Each attic had a different ridge vent treatment: the west attic used a baffled ridge vent, while the east attic used one of the two rolled ridge vents tested. All three ridge vent treatments provided 2.25 ft^2 of free vent area. The net free vent area required, based on federal guidelines, for an attic of this size would be 3.12 ft^2. The tested treatments provided a total net free vent area of 4.5 ft^2 for the combined ridge and soffit treatments.

The measurements were made in two bays of each attic. A bay was defined as the unobstructed spaces between a pair of trusses. To minimize any obstruction the weather station may have had on airflow over the ridge, the first bay selected for measurement was located three bays from the instrumentation chamber wall (see light gray area in Figure 1). A second bay, located two bays from the gable ends of the building, also was monitored. Each attic was equipped with a pull-down ladder following the conventional design in most homes. The conditioned space underneath the attics consisted of two identical rooms. Efforts were made to keep these rooms at similar temperature and moisture conditions.

It was expected that the airflow patterns around the building were influenced by the close proximity of other buildings and trees. A site map was thus prepared as shown in Figure 2. There were buildings and 125 ft (38.1 m) high trees in all directions around the research building.

INSTRUMENTATION

Two programmable dataloggers were used to monitor 105 channels of data, including weather data, recorded once every minute. The dataloggers were connected via coaxial cable to a computer that downloaded the data in the dataloggers every three hours and stored it. Because most of the sensors required individual calibration equations, a database was created to store the raw voltage data downloaded from the dataloggers and perform the calculations that provide the reduced data.

The building was equipped with a weather station, located directly over the instrumentation chamber, that collected data on wind conditions, solar radiation, rainfall, and outside temperature. Because the pyranometer that measured solar radiation on the building was positioned directly above the instrumentation chamber, and cloud coverage and trees can shade the roof unevenly, 16 thermocouples were placed on the roof. This allowed the shading on the roof to be considered when analyzing the temperature data inside the attic. Figure 3 provides the location of the sensors in one of the four bays monitored. As discussed earlier, when ridge and soffit vents were used collectively, air movement was confined predominantly to the underside of the roof deck, leaving a pocket of stagnant air at the center of the attic. Consequently, sensors were clustered in the ridge and soffit areas.

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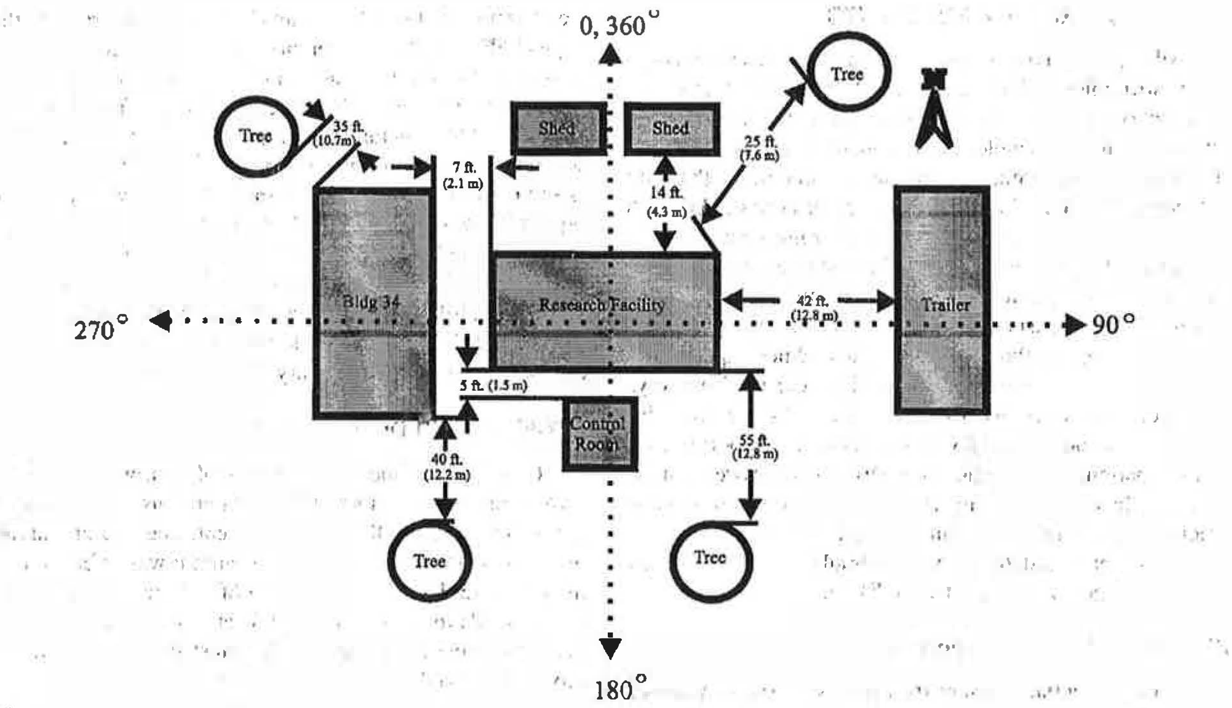
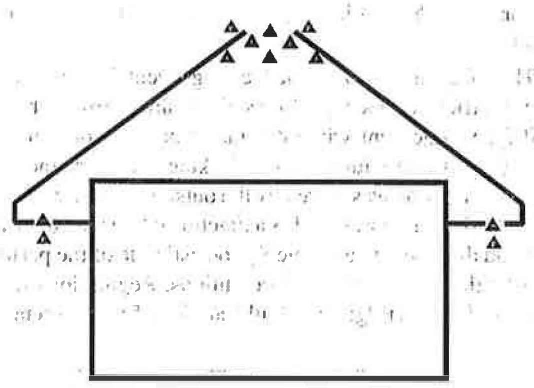


Figure 2 *Site map showing general arrangement of buildings and of other obstructions near the research facility.*



▲ Thermocouple with vertical and horizontal air flow sensors.
▲ Thermocouple with vertical air flow sensor.
▲ Differential pressure transducer.

Figure 3 *Schematic showing sensor placement.*

It was assumed that at the ridge and soffits the airflow was mainly in the vertical direction. Therefore, thermocouples and vertical component airflow sensors were placed there. Differential pressure transducers were placed at the soffits and on either side of the ridge. For the air inside the attic, where the airflow was three-dimensional, horizontal and vertical airflow sensors were used so that a velocity vector diagram could be constructed. This sensor configuration also allowed quantification of thermal buoyancy on days with no wind. When there was no outside wind, the vertical airflow sensors inside the attic should account for most, if not all, of the airflow, since the driving force for ventilation under those conditions comes from thermal buoyancy.

Because the airflow sensors selected for this study cannot account for direction, differential pressure sensors were placed at the ridge and soffits to determine the gross direction of air movement. The differential pressure transducers were placed on the same wall of the instrumentation chamber, with plastic tubing extending to the specific locations. At the soffits, the high-pressure side of the differential pressure transducer was placed directly below the soffit and the low-pressure side directly inside the soffit. In operation, if the differential sensor read a positive value, the soffit was acting as an inlet; conversely, if it read a negative value, it was acting as an outlet.

The ridge airflow was more complicated as the ridge had two sides and, conceivably, air can come in one side and go directly out the other side. The ideal performance occurred when both sides of the ridge vent were outlets for the hot air inside. Therefore, at the ridge, differential pressure sensors were placed on either side of the ridge. The high-pressure side of each sensor was located directly outside of the ridge, and the low-pressure side was located directly inside. A positive pressure differential reading indicated that air was entering the attic through the ridge.

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TEMPERATURE MEASUREMENTS

All the temperature measurements were taken with type-T thermocouples with leads 65 ft (19.8 m) in length; measuring junctions were factory constructed by the manufacturer. Forty-eight thermocouples were connected to two multiplexers, each with a thermistor reference junction. A fifth-order polynomial, resident in the datalogger, converts the EMF to temperature. All the thermocouples measuring air temperature were shielded from the effect of thermal radiation by a patch of highly reflective aluminum foil over the junctions. The thermocouples measuring the roof temperature were placed directly underneath the shingle tabs and did not require radiation shields, but for consistency they were used anyway. Possible sources of error for the thermometry included the precision and accuracy of voltage readings, the polynomial approximation, and variations in thermocouple wire or junction manufacturing. The largest source of error came from the precision of the reference junction. Two different reference junctions were used (one for each multiplexer), each one having an accuracy of ±0.4°C (±0.7°F).

Differential Pressure Sensors

The differential pressure transducers were calibrated at the factory and had a pressure range of –0.1 to +0.1 in. of water (–24.9 Pa to 24.9 Pa) and an accuracy of ±0.002 in. of water (±0.6 Pa). The transducers worked on the principle of variable capacitance. Each sensor had a 65 ft (19.8 m) length of plastic tubing and a static pressure tap at the end to minimize the error caused by different tube lengths.

Because of high wind gusts, additional protection was given to the static taps. They were inserted in a plastic vial with three small holes drilled in the cap.

Weather Station

Outside wind conditions were monitored with a factory-calibrated cup anemometer and wind vane located 5.5 ft (1.68 m) above the center of the ridge. The wind measurements had a range of 0 to 112 mph (0 to 50 m/s) over a 360° direction. Rainfall was measured with a calibrated tipping bucket rain gauge, while solar radiation was measured with a factory-calibrated pyranometer made of a silicone photodiode. Outside ambient temperature was measured with a type-T thermocouple inserted in a 12-plate gill type radiation shield.

Airflow Measurements

The airflow sensors consist of two thermistors (thermal sensitive resistors) and a hybrid-integrated-circuit chip. One was heated and used as an airspeed-sensing element operated under the constant temperature mode, and the other was used as a temperature-compensating element. Because measurements below 100 ft/min (0.5 m/s) require high sensitivity, special care was taken in the calibration of these sensors.

A wind tunnel was constructed and calibrated using a laser-verified air velocity transducer. All the airflow sensors were then calibrated inside this tunnel. The accuracy of the tunnel calibration was a combination of the accuracy of the transducer used to calibrate it and the fluctuations in the speed of the fan. To reduce the error caused by the fluctuations in speed of the wind tunnel's fan, a highly regulated power supply with a voltage fluctuation of ± 0.0005 V was selected as the power source. The combined error caused by the fan speed fluctuation and the transducer's accuracy was converted to an equivalent airspeed uncertainty of ±4 ft/min (± 0.02 m/s). Each sensor had a cable length of 65 ft (19.8 m) to minimize errors due to the length of the cable. This made the sensors more versatile, as they could be redeployed in whatever configuration may be necessary throughout the structure.

RESULTS AND DISCUSSION

One hundred and five channels of data were collected every minute for 10 months. Of the enormous amount of data collected, only a small sample is presented here to summarize the results and trends observed. Because it was inferred from the literature that the combination of a ridge vent and soffit vents would provide the most consistent attic ventilation, three of the most common ridge vents were tested to find the one that provided the highest rate of ventilation.

The first test involved establishing the symmetry of the two attics by running paired tests with the same ridge treatment. The airspeed and differential pressures at the ridge were very similar for both attics, as can be seen from Figures 4 and 5 a and b.

Then the shingle-over-plastic ridge vent with external baffles (baffled vent) was compared to the shingle over fibrous rolled type ridge vent without a fabric backing or external baffles (rolled vent without fabric backing). Because most of the attic ventilation was driven by the outside wind, a comparison of the ridge airflow speed as a function of the outside wind speed and direction would give a good estimate of the performance of the vent for all wind conditions. Regressions were performed for both ridge vents with data from five consecutive

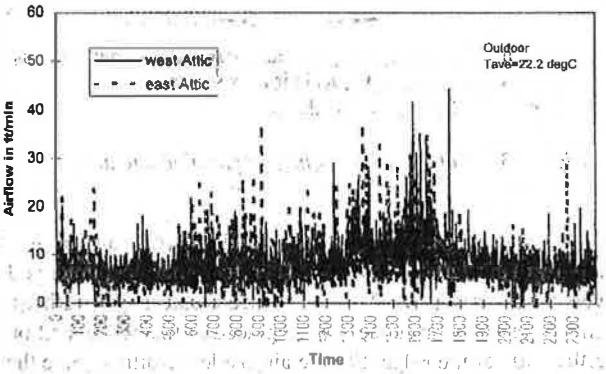

Figure 4 Airflow at the ridge when both the east and west attics were fitted with the baffled vent, for October 3, 1996.

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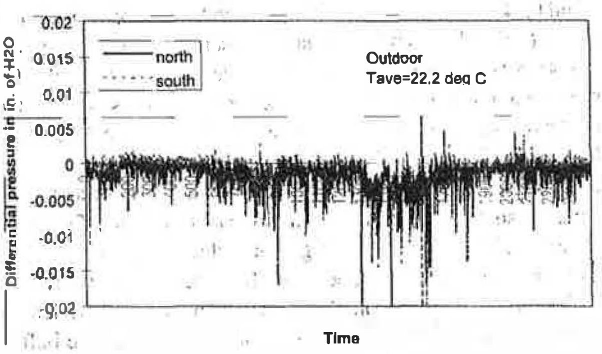

Figure 5a *Differential pressure at the ridge for the west attic fitted with the baffled vent for October 3, 1996.*

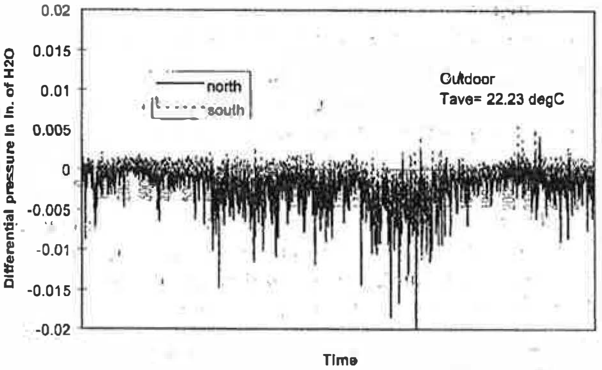

Figure 5b *Differential pressure at the ridge for the east attic fitted with baffled vent for October 3, 1996.*

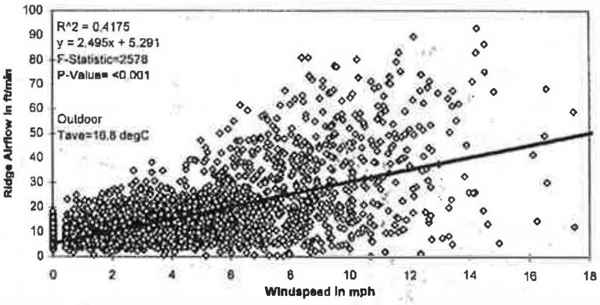

Figure 6a *Baffled ridge vent ridge airflow as a function of wind speed for the week of November 6 through November 10, 1995.*

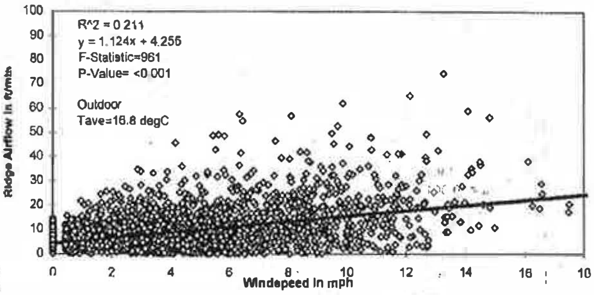

Figure 6b *Rolled ridge vent without fabric backing ridge airflow as a function of wind speed for the week of November 6 through November 10, 1995.*

days, and results showed that the baffled vent provided faster airflow throughout all wind speeds (Figures 6a and 6b). During the period selected for the comparison in November, the average outside wind speed was 3.53 mph (1.585 m/s), covering a range from 0 to 19 mph (0 to 8.49 m/s). The average wind direction was coming from the north. The slope of the regression lines quantified the performance of the vent: the rolled vent without fabric backing had a slope of only 1.124, while the baffled vent had a slope of 2.495. This suggested that the baffled vent would provide approximately twice the ventilation of the rolled vent without fabric backing for the same wind conditions.

Next, the baffled ridge vent was compared to a shingle over fibrous rolled ridge vent with a fabric backing but without external baffles (fabric backed rolled vent). The regression lines for the baffled vent and the fabric-backed rolled vent are presented in Figures 7a and 7b. For the period selected for comparison during the month of May, the average outside wind speed was 2.4 mph (1.07 m/s) over a range of 0 to 12 mph (0 to 5.36 m/s), while the average wind direction was from the southwest. As was the case in the previous test, the baffled vent provided higher airflow speeds for all outside wind conditions. The slope of the baffled vent's regression line was 3.100 compared to the slope of the fabric-backed rolled vent of only 1.306. Suggesting that the baffled vent provided almost 3 times the ventilation of the fabric backed rolled vent for the same wind conditions. Analysis showed that the slopes of Figures 6 and 7 are statistically different from zero, as evidenced by the F-statistic and P-value, and the unexplained variability is smaller than expected from random sampling.

The large scatter of data seen in Figures 6 and 7 is typical of field measurements like the ones taken during this project. It was suspected that this scatter was caused by the sheltering effect of other buildings and trees located nearby. This effect is seen clearly in Figure 8. The ridge airflow data were separated by wind direction, and distinct clusters of data were found that correlated with the unobstructed wind paths. The largest ridge airflows were found for winds from the north (0° and 360°) and winds from the southwest (200° through 250°). The minimum airflows resulted from winds from the northwest (270° through 300°) and from the southeast (150°), both of which were in the general direction of nearby trees with large canopies that blocked the wind. Similar figures were obtained for the two rolled vents but were omitted for brevity's sake.

Weekly data similar to that presented above provided a valuable tool for analyzing the general performance of a vent, but a closer look was necessary. An attempt was made to compare the performance of the baffled vent to the rolled vent without fabric backing on a single day (November 4, 1995)

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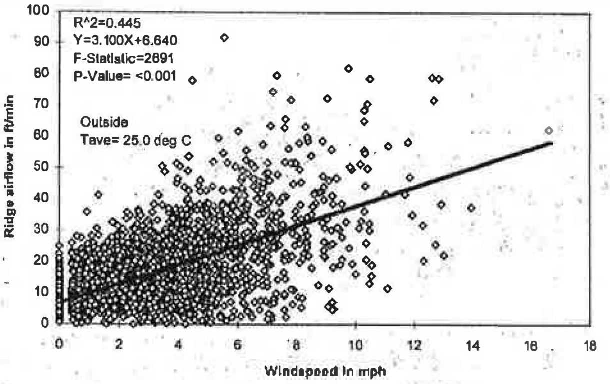

Figure 7a *Baffled vent ridge airflow as a function of wind speed for the week of May 27 through May 31, 1996.*

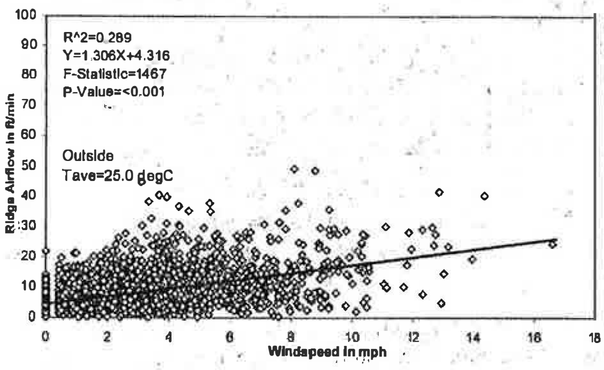

Figure 7b *Fabric backed rolled vent ridge airflow as a function of wind speed for the week of May 27 through May 31, 1996.*

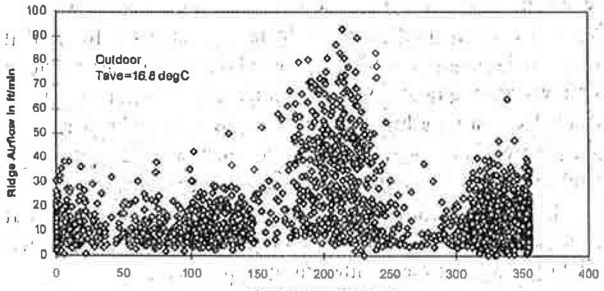

Figure 8 *Baffled vent ridge airflow as a function of wind direction for the week of November 6 through November 10, 1995.*

and the baffled vent to the fabric-backed rolled vent on another day (June 5, 1996). The days presented were selected at random and other days studied showed the same trends. The first parameter compared was the airflow speeds at the ridge. In this case, both attics had the same soffit treatment so differences in airspeed would be due to differences in the ridge vents. Generally, the results indicated that better performance was associated with faster airflow at the ridge. Figure 9a compares the airflow through the ridge for the rolled vent without fabric backing and the baffled vent under an average wind speed of 4.11 mph (1.79 m/s) from the north. It demonstrates that, for most of the day, airflow through the baffled ridge vent was faster than through the rolled vent without fabric backing. When the baffled vent was compared to the fabric-backed rolled vent (Figure 9b), the baffled vent again provided faster airflow. Data in Figure 9b were collected under an average wind speed of 2 mph (0.89 m/s) from the southwest.

Airspeed through the ridge alone is not the sole indicator of the performance of a ridge vent. The airflow sensors used for this project could not detect airflow directions. Thus, a high airspeed, if it occurred in the wrong direction, could make the vent unusable for attic ventilation. In the ideal case, the soffit vents draw air into the attic, and the ridge vents exhausts it through both sides (both sides of the ridge under negative differential pressure). If the direction of the airflow were

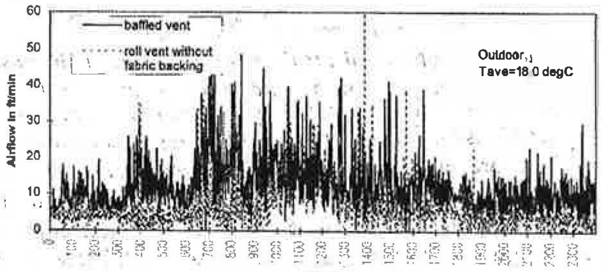

Figure 9a *Airflow at the ridge; rolled vent without fabric backing vs. baffled vent, for November 4, 1995.*

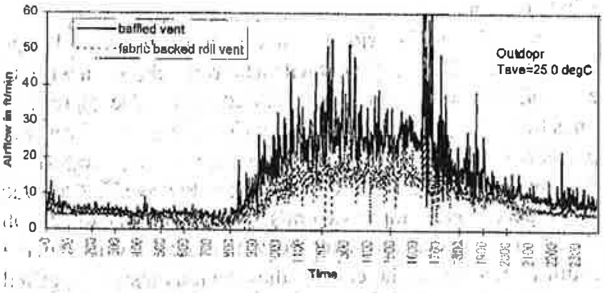

Figure 9b *Airflow at the ridge, fabric backed rolled vent vs. baffled vent for June 5, 1996.*

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reversed, the effect of thermal buoyancy inside the attic would be suppressed. Ridge vents could also short-circuit by air entering through one side of the ridge (the side under positive differential pressure) and exiting through the other the side under negative differential pressure).

A close examination of the data revealed that on November 4 the outside wind speed was consistently above zero. These data were thus selected for comparison. Figure 10a shows that the baffled vent had both sides of the ridge reading negative differential pressures, which meant they were both behaving as air outlets, the preferred condition. The rolled vent without fabric backing, on the other hand, was being short-circuited. As seen in Figure 10b, the north side of the vent was behaving as an outlet, while the south side of the vent was behaving as an inlet.

For the June 5 comparison (Figures 11a and 11b) of the baffled vent and fabric-backed rolled vent, it was important to note that the outside wind was zero between midnight and 8 a.m. and from 8 p.m. to midnight. There was a burst of wind between 10 a.m. and 11 p.m. During the periods of wind speeds below 2 mph (0.894 m/s), the differential pressure readings were within the error band of the sensor and thus no trends can be observed. At higher wind speeds, both vents behaved in a similar manner. The baffled vent had a negative differential pressure at both sides of the ridge, as shown in Figure 11a. A surprising result was that the fabric-backed rolled vent behaved in a similar manner, as shown in Figure 11b. Some ridge vent manufacturers imply that only baffled vents provide negative pressures on both sides of the vent, but the present results show that the fabric-backed rolled vent tested also provides these conditions. To verify this, data for several days were analyzed and a consistent trend was found. The value of having both differential pressure readings and airflow sensor readings became apparent. Based solely on the differential pressures, both vents appeared to function similarly. However, once the airflow results of Figure 9b were taken into consideration, the baffled vent was shown to provide more ventilation.

Physically, as heat accumulates in the attic, the highest temperature will be found at the ridge section of the attic. A well-ventilated attic would lower the attic temperature. As shown in Figure 12a, the baffled vent had lower ridge temperatures, a result that was consistent with better ventilation. Indeed, at the ridge of the baffled vent side, there was an almost constant temperature of 53°C (127.4°F), which is 4°C (7.2°F) cooler than the attic fitted with the fabric-backed rolled vent. The stratification of the attic temperature on the fabric-backed rolled vent side can be seen in Figure 12b. Similar results were obtained for the comparison of the baffled vent and roll vent without fabric backing. The baffled vent side presented a ridge temperature of 23.3°C (74°F) which was 12°C (21°F) cooler than the attic fitted with the roll vent without fabric backing.

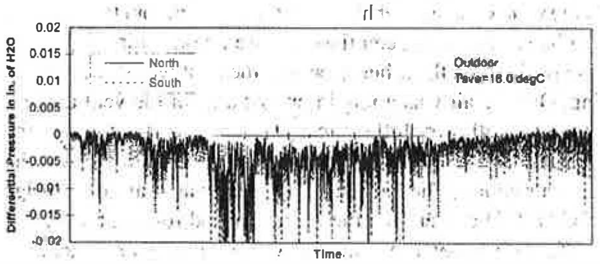

Figure 10a *Differential pressure at the ridge for the baffled vent for November 4, 1995.*

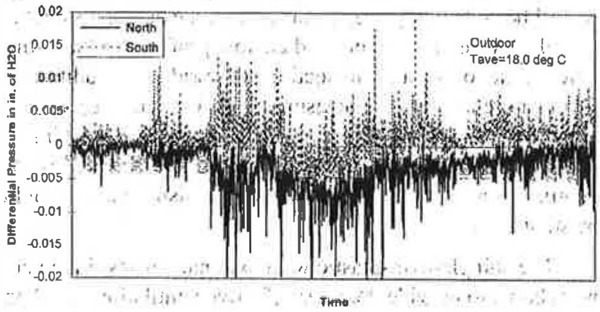

Figure 10b *Differential pressure at the ridge for rolled vent without fabric backing for November 4, 1995.*

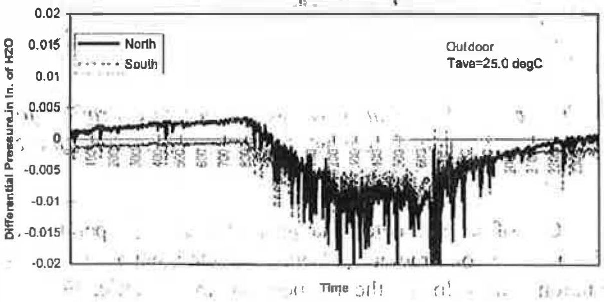

Figure 11a *Differential pressure at the ridge for the baffled vent, for June 5, 1996.*

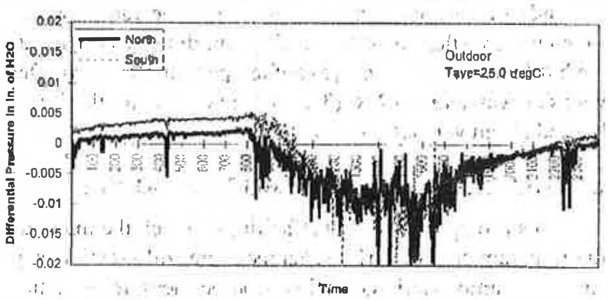

Figure 11b *Differential pressure at the ridge for fabric backed rolled vent, for June 5, 1996.*

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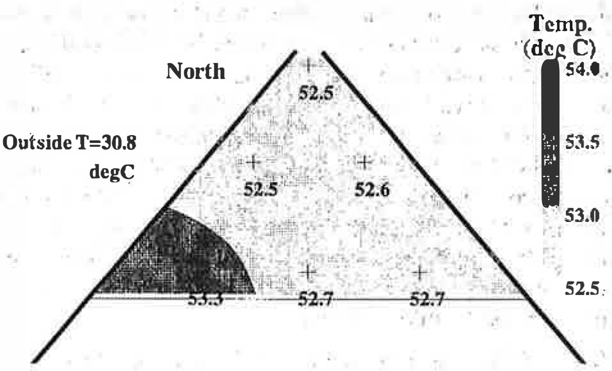

Figure 12a *Close up of ridge temperature profiles for baffled vent for June 5, 1996 at noon.*

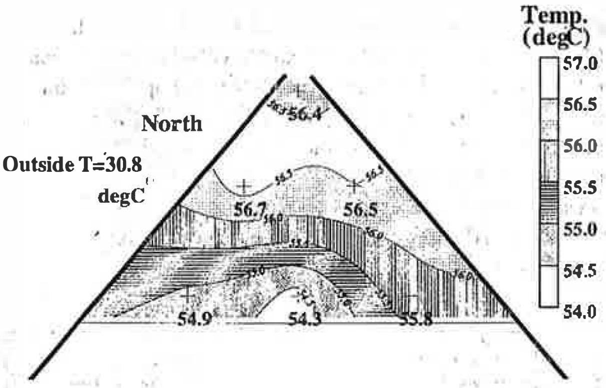

Figure 12b *Close up of ridge temperature profiles for rolled vent with fabric backing for June 5, 1996 at noon.*

One of the parameters that may affect attic temperature is the incident solar radiation. It was expected that a lower irradiation would lower the temperature in the attic. For the present study, both attics tested were on the same building and, therefore, exposed to the same level of solar radiation. Increased ventilation would keep the roof deck cooler. The east side of the building was fitted with the fabric-backed rolled vent, while the west side of the building was fitted with the baffled vent. The average roof temperature for the baffled vent side was actually 2° C (3°F) lower than that for the fabric-backed rolled vent (Romero 1996).

CONCLUSIONS AND RECOMMENDATIONS

This project established a facility in which the microclimatic parameters of airflow, temperature, differential pressure, and atmospheric conditions can be measured in attics. The conclusion as to which ridge vent was more effective could only be made because the west and east attics performed similarly when fitted with the same ridge vent. A paired test was run with both attics having the same ridge vent; the speed of the air and the differential pressures at the ridge were very similar. The mean airspeed difference between the west attic and the east attic when they were both fitted with the same baffled vent was 1.24 ft/min (0.006 m/s) with a standard error of the mean (SEM) of 0.14 for a 1440 data point sample. This means there are no inherent differences between the two attics, and any differences in airspeed or differential pressures observed when different vents are used on opposite sides are due to the vent.

Three ridge vents were compared in paired tests. The regression lines presented earlier showed the baffled vent providing twice the airspeed at the ridge of the rolled vent without fabric backing and three times the airspeed of the fabric-backed roll vent. If both sides of the ridge vent were known to be exhausting air from the attic, then the above results would be enough to conclude that the baffled vent provides twice the ventilation of rolled vents without fabric backing and three times the ventilation of fabric-backed roll vents.

Airspeed at the ridge alone in not a good measure of the performance of a ridge vent when both the airspeed and the direction of the air through it need to be studied. The direction of the airflow at the ridge can be obtained from the differential pressures at each side of the ridge. The results showed that both the baffled vent and the fabric-backed roll vent had negative differential pressures on both sides of the ridge, indicating that attic air was being exhausted through both sides of the ridge vent. On the other hand, the roll vent without fabric backing had negative differential pressure on one side of the vent and positive on the other, meaning the vent was short-circuiting. Outside air was going in on one side of the vent and out the other with very little attic air being exhausted through the vent. It has been shown that better attic ventilation keeps the attic air cooler. The baffled vent kept the attic air at the ridge 4°C (7.2°F) cooler than the fabric-backed roll vent side, and 12°C (21°F) cooler than the roll vent without fabric backing.

Two bays of each attic were instrumented to monitor conditions at the ridge. Both bays of each attic performed similarly; therefore, only one bay needs to be used in future tests and the instrumentation presently used on the second bay should be distributed evenly throughout the attic cavity. This would provide temperature and airflow profiles for the entire attic instead of for a small section at the ridge. In addition to temperature and airflow measurements, it would be useful if humidity measurement were made. With the additional information, a variety of questions regarding the effectiveness of ventilation as a moisture-removal mechanism in attics could be studied.

The shingle-over-plastic with external baffles ridge vent was shown to provide the most effective ventilation based on airflow speed, differential pressure, and temperature measurements at the ridge. Therefore, it should be installed on both attics for further studies on the parameters that would minimize arthropod survival.

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