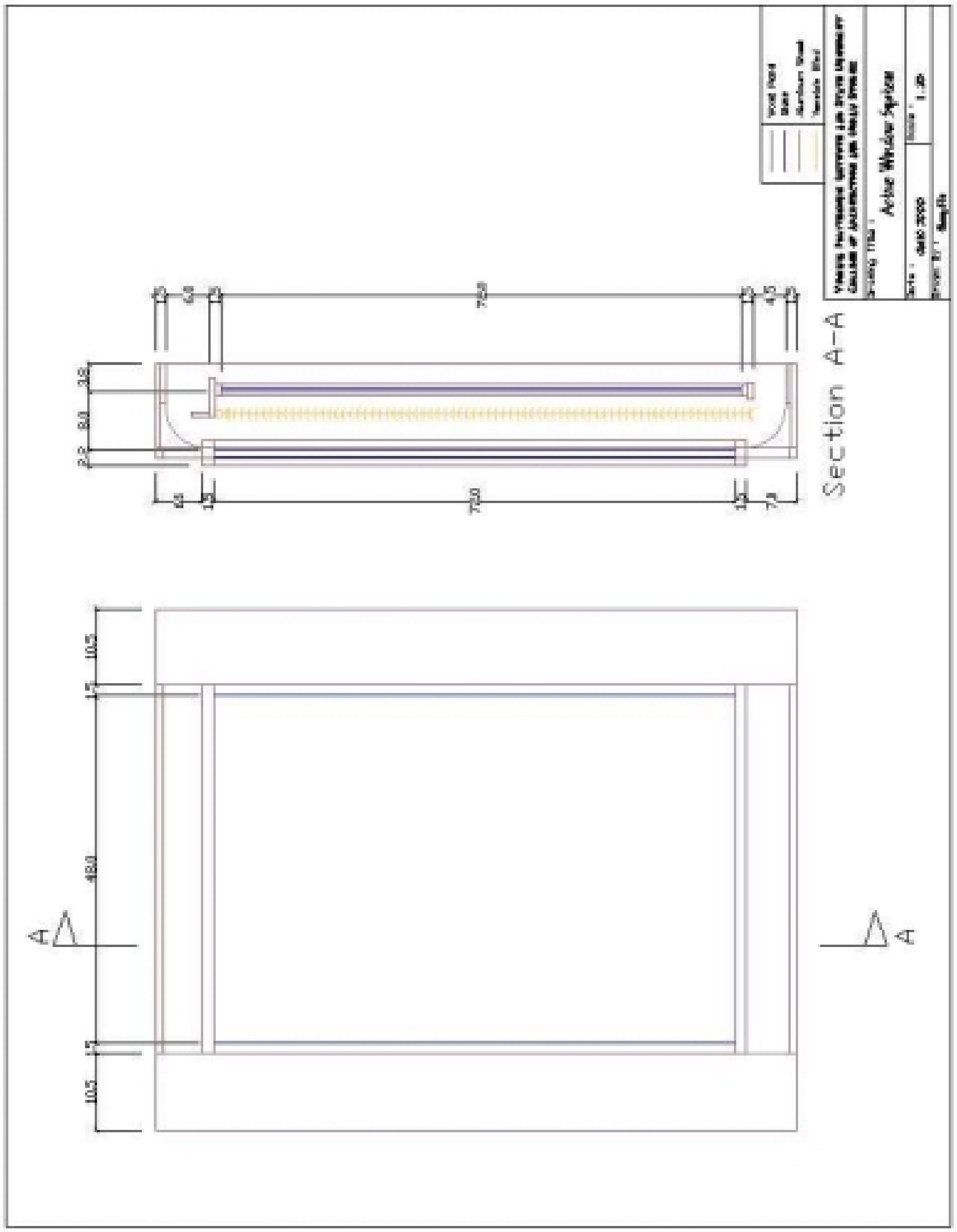
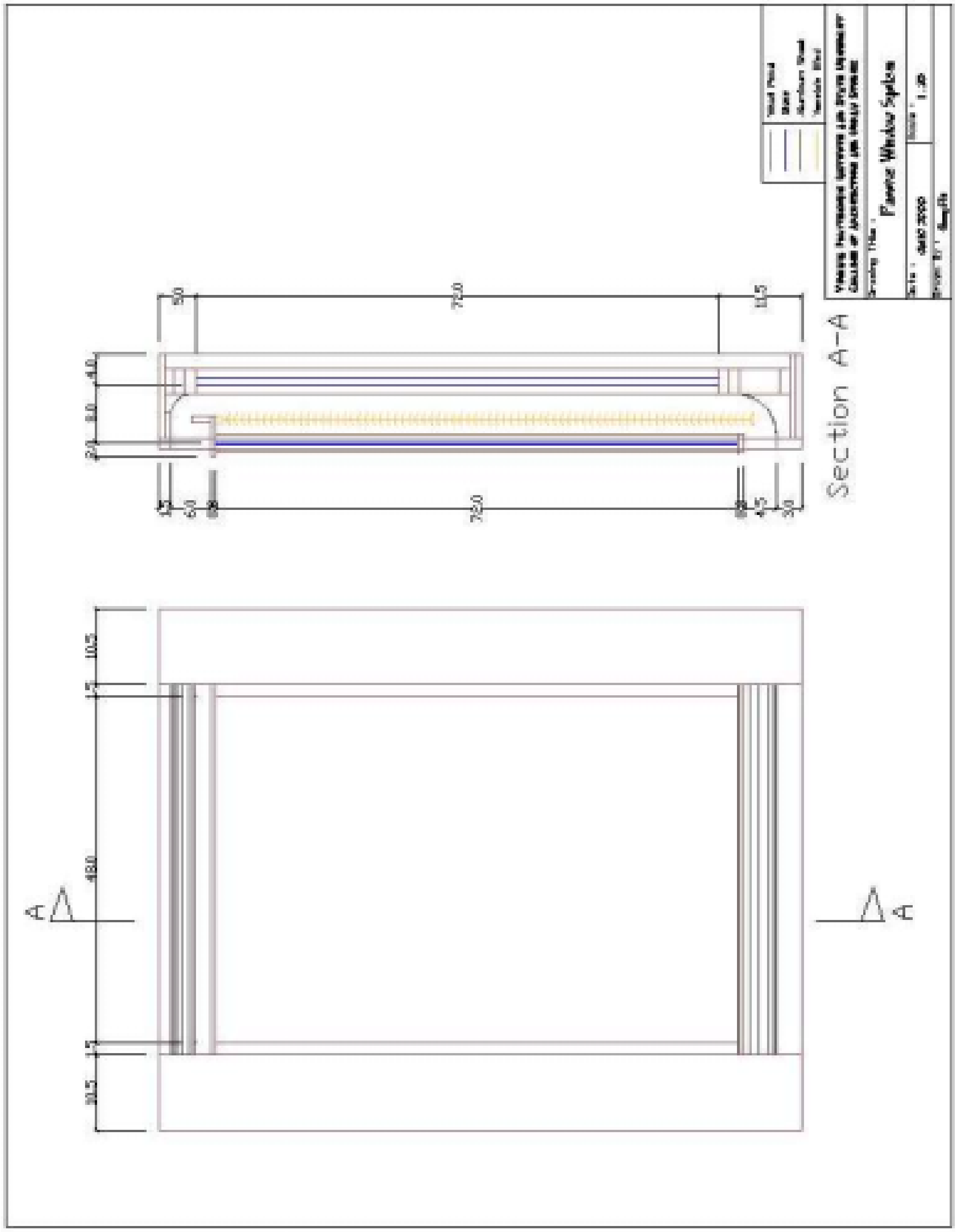
**Appendix A**
The detail drawing of active window



**Appendix B**
The detail drawing of passive window



**Appendix C**
The descriptive statistics of the temperature for both systems

| | Mean | Std. | Std. | Minimu | Maximu |
|---|---|---|---|---|---|
| 1. A-upper cavity air | 78.451 | 5.704 | .271 | 66.322 | 93.128 |
| 2. A-upper cavity outdoor glass | 89.158 | 9.801 | .466 | 69.875 | 111.934 |
| 3. A-upper cavity outer air | 82.569 | 6.973 | .331 | 68.078 | 99.154 |
| 4. A-upper cavity inner air | 81.257 | 6.052 | .288 | 68.462 | 95.310 |
| 5. A-upper cavity indoor glass | 81.677 | 6.262 | .298 | 68.440 | 96.200 |
| 6. A-upper indoor | 77.654 | 4.835 | .230 | 67.236 | 88.972 |
| 7. A-lower cavity outdoor glass | 80.463 | 6.212 | .295 | 66.997 | 96.141 |
| 8. A-lower cavity outer air | 76.079 | 4.951 | .235 | 65.615 | 88.556 |
| 9. A-lower cavity inner air | 83.500 | 6.918 | .329 | 68.826 | 99.778 |
| 10. A-lower cavity indoor glass | 83.006 | 6.619 | .314 | 68.680 | 98.843 |
| 11. A-lower indoor | 76.241 | 4.730 | .225 | 66.145 | 87.517 |
| 12. A-lower cavity air | 71.034 | 4.629 | .220 | 62.675 | 81.491 |
| 13. A-room | 69.945 | 4.593 | .218 | 61.720 | 81.318 |
| 14. P-upper cavity air | 79.678 | 6.894 | .328 | 63.480 | 98.800 |
| 15. P-upper cavity outdoor glass | 81.302 | 8.097 | .385 | 63.510 | 104.500 |
| 16. P-upper cavity outer air | 85.246 | 9.189 | .437 | 65.800 | 110.600 |
| 17. P-upper cavity inner air | 79.855 | 6.540 | .311 | 64.470 | 97.300 |
| 18. P-upper cavity indoor glass | 79.989 | 6.323 | .300 | 65.230 | 96.600 |
| 19. P-upper indoor | 74.878 | 4.158 | .198 | 65.420 | 84.700 |
| 20. P-lower cavity outdoor glass | 77.375 | 7.042 | .335 | 61.520 | 98.500 |
| 21. P-lower cavity outer air | 80.523 | 7.777 | .370 | 63.420 | 104.600 |
| 22. P-lower cavity inner air | 73.024 | 6.074 | .289 | 60.820 | 86.500 |
| 23. P-lower cavity indoor glass | 73.769 | 5.913 | .281 | 61.580 | 87.700 |
| 24. P-lower indoor | 72.586 | 3.945 | .187 | 64.330 | 81.800 |
| 25. P-lower cavity air | 71.477 | 6.473 | .308 | 57.930 | 85.700 |
| 26. P-room | 69.243 | 3.845 | .183 | 62.410 | 78.500 |
| 27. outdoor | 70.178 | 6.819 | .324 | 60.129 | 85.543 |

The descriptive statistics of the environmental factors

| | Mean | Std. Dev. | Std. Error | Minimum | Maximum |
|---|---|---|---|---|---|
| A-cavity air flow rate | 38.205 | 3.707 | .176 | 26.760 | 45.010 |
| P-cavity air flow rate | 24.037 | 9.190 | .437 | 9.520 | 55.320 |
| wind speed | 1.636 | .663 | .031 | 0.000 | 3.276 |
| wind direction | 204.874 | 63.418 | 3.013 | 90.700 | 287.900 |
| vertical solar radiation | .302 | .146 | .007 | .100 | .606 |

**Appendix D**
Regression results of the active system cavity solar heat removed vs. four factors

- Active: Fraction of Cavity Solar Heat Removed (A- Fhr) vs. solar radiation (Ev)

| | |
|---|---|
| Count | 402 |
| Num. Missing | 0 |
| R | .386 |
| R Squared | .149 |
| Adjusted R Squared | .147 |
| RMS Residual | .132 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | 1.223 | 1.223 | 69.981 | <.0001 |
| Residual | 400 | 6.990 | .017 | | |
| Total | 401 | 8.213 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .695 | .016 | .695 | 42.723 | <.0001 |
| Ev | -.389 | .047 | -.386 | -8.365 | <.0001 |

Regression Plot

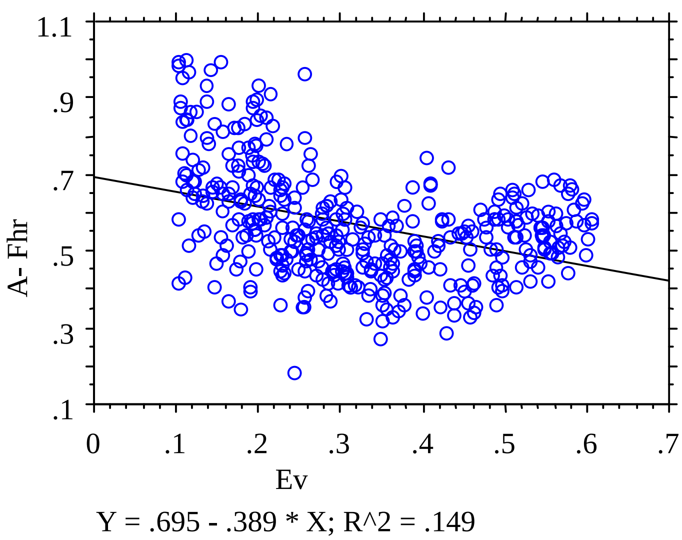



Figure A1 Regression results for the active system: A- Fhr vs. Ev

- Active: Fraction of Cavity Solar Heat Removed (A- Fhr) vs. Outdoor Air Temperature (OAT)

Regression Summary

| | |
|---|---|
| Count | 402 |
| Num. Missing | 0 |
| R | .254 |
| R Squared | .064 |
| Adjusted R Squared | .062 |
| RMS Residual | .139 |

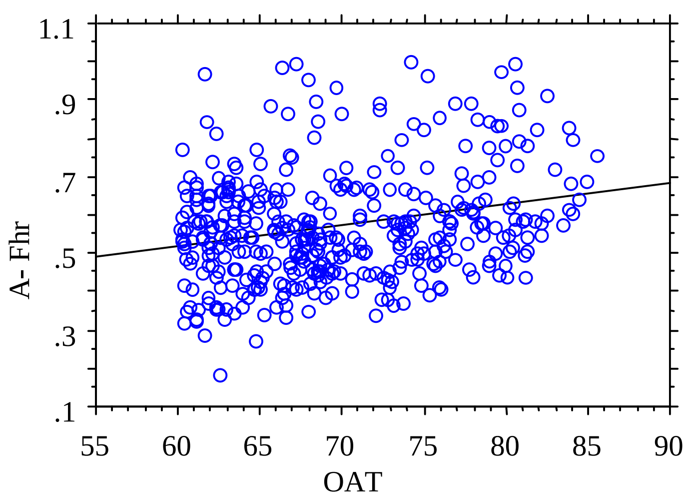
ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .528 | .528 | 27.476 | <.0001 |
| Residual | 400 | 7.685 | .019 | | |
| Total | 401 | 8.213 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .189 | .073 | .189 | 2.580 | .0102 |
| OAT | .005 | .001 | .254 | 5.242 | <.0001 |

Regression Plot




Y = .189 + .005 * X; R^2 = .064

Figure A2 Regression results for the active system: A- Fhr vs. OAT

- Active: Fraction of Cavity Solar Heat Removed (A- Fhr) vs. Wind Speed (WS)

Regression Summary

| | |
|---|---|
| Count | 402 |
| Num. Missing | 0 |
| \|R\| | .206 |
| R Squared | .042 |
| Adjusted R Squared | .040 |
| RMS Residual | .140 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .349 | .349 | 17.752 | <.0001 |
| Residual | 400 | 7.864 | .020 | | |
| Total | 401 | 8.213 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .644 | .019 | .644 | 34.170 | <.0001 |
| WS | -.044 | .011 | -.206 | -4.213 | <.0001 |

Regression Plot

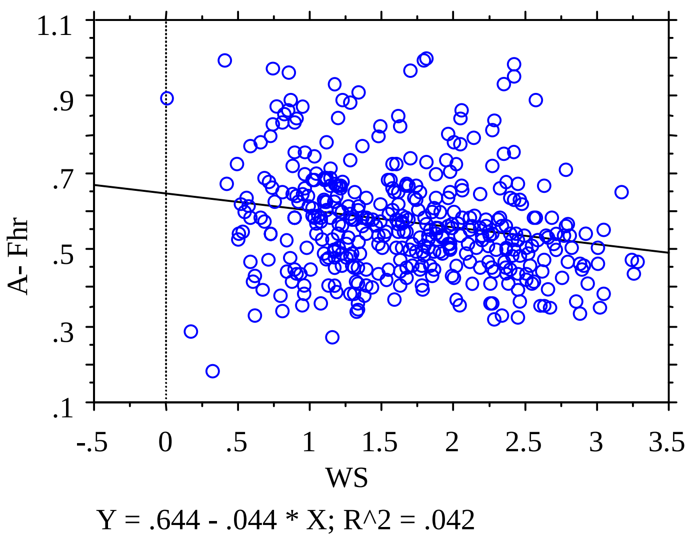



Figure A3 Regression results for the active system: A- Fhr vs. WS

- Active: Fraction of Cavity Solar Heat Removed (A- Fhr) vs. Wind Direction (WD)

Regression Summary

| | |
|---|---|
| Count | 402 |
| Num. Missing | 0 |
| \|R\| | .103 |
| R Squared | .011 |
| Adjusted R Squared | .008 |
| RMS Residual | .143 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .088 | .088 | 4.310 | .0385 |
| Residual | 400 | 8.125 | .020 | | |
| Total | 401 | 8.213 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .619 | .024 | .619 | 25.493 | <.0001 |
| WD | -2.337E-4 | 1.125E-4 | -.103 | -2.076 | .0385 |

Regression Plot

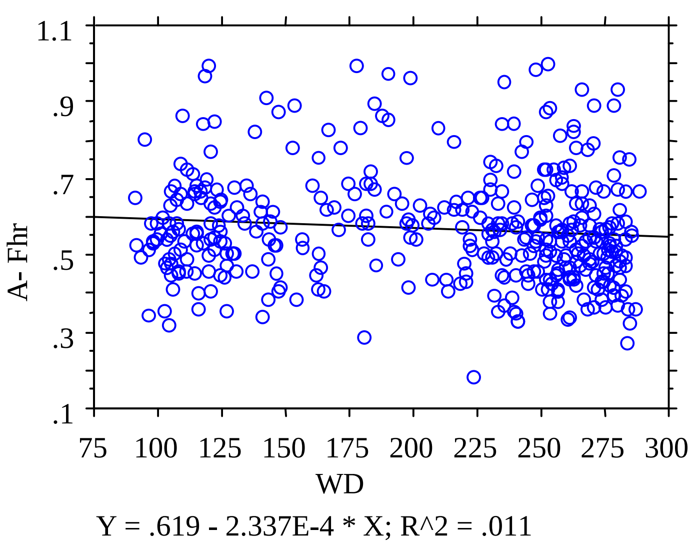



Figure A4 Regression results for the active system: A- Fhr vs. WD

**Appendix E**
Regression results of the passive system cavity solar heat removed vs. four factors

- Passive: Fraction of Cavity Solar Heat Removed (P- Fhr) vs. solar radiation (Ev)

| | |
|---|---|
| Count | 402 |
| Num. Missing | 0 |
| \|R\| | .234 |
| R Squared | .055 |
| Adjusted R Squared | .053 |
| RMS Residual | .097 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .218 | .218 | 23.239 | <.0001 |
| Residual | 400 | 3.746 | .009 | | |
| Total | 401 | 3.964 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .272 | .012 | .272 | 22.885 | <.0001 |
| Ev | .164 | .034 | .234 | 4.821 | <.0001 |

Regression Plot

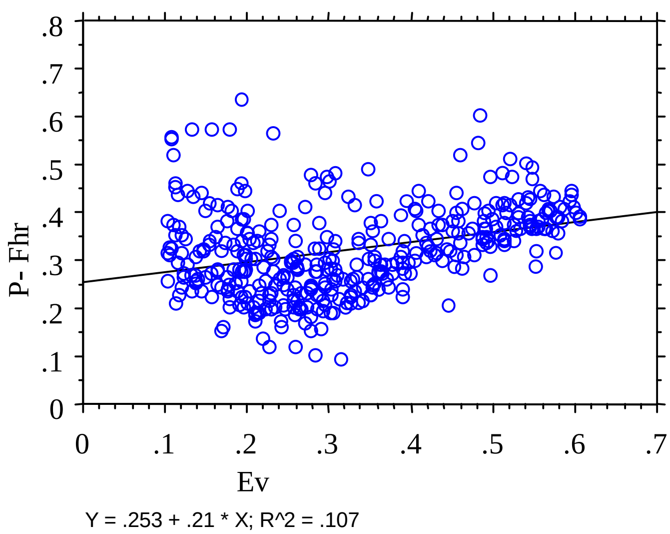



Figure A5 Regression results for the passive system: P- Fhr vs. Ev

- Passive: Fraction of Cavity Solar Heat Removed (P- Fhr) vs. Outdoor Air Temperature (OAT)

Regression Summary

| | |
|---|---|
| Count | 402 |
| Num. Missing | 0 |
| R | .298 |
| R Squared | .089 |
| Adjusted R Squared | .087 |
| RMS Residual | .095 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .352 | .352 | 38.973 | <.0001 |
| Residual | 400 | 3.612 | .009 | | |
| Total | 401 | 3.964 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .637 | .050 | .637 | 12.694 | <.0001 |
| OAT | -.004 | .001 | -.298 | -6.243 | <.0001 |

Regression Plot

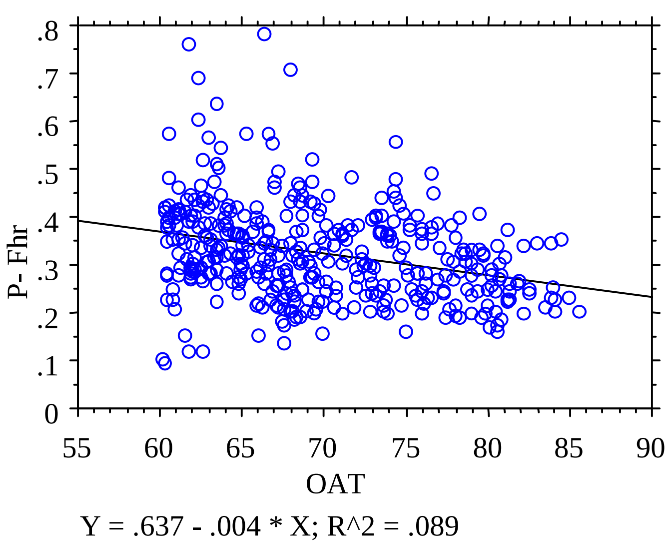



Figure A6 Regression results for the passive system: P- Fhr vs. OAT

- Passive: Fraction of Cavity Solar Heat Removed (P- Fhr) vs. Wind Speed (WS)

Regression Summary

| | |
|---|---|
| Count | 402 |
| Num. Missing | 0 |
| \|R\| | .259 |
| R Squared | .067 |
| Adjusted R Squared | .065 |
| RMS Residual | .096 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .266 | .266 | 28.803 | <.0001 |
| Residual | 400 | 3.698 | .009 | | |
| Total | 401 | 3.964 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .261 | .013 | .261 | 20.151 | <.0001 |
| WS | .039 | .007 | .259 | 5.367 | <.0001 |

Regression Plot

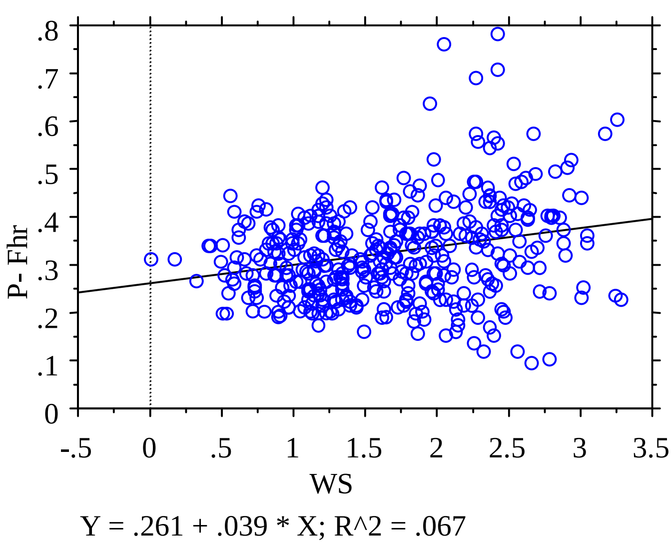



Figure A7 Regression results for the passive system: P- Fhr vs. WS

- Passive: Fraction of Cavity Solar Heat Removed (P- Fhr) vs. Wind Direction (WD)

Regression Summary

| | |
|---|---|
| Count | 402 |
| Num. Missing | 0 |
| \|R\| | .439 |
| R Squared | .192 |
| Adjusted R Squared | .190 |
| RMS Residual | .089 |

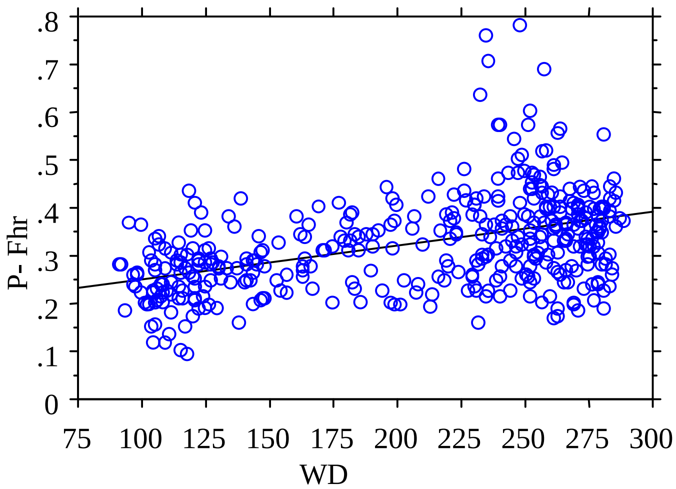
ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .763 | .763 | 95.317 | <.0001 |
| Residual | 400 | 3.201 | .008 | | |
| Total | 401 | 3.964 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .183 | .015 | .183 | 11.999 | <.0001 |
| WD | .001 | 7.064E-5 | .439 | 9.763 | <.0001 |

Regression Plot




Y = .183 + .001 * X; R^2 = .192

Figure A8 Regression results for the passive system: P- Fhr vs. WD

**Appendix F**
Regression results of the cavity solar heat removed vs. solar radiation > 0.25 Btu/h*ft$^2$

- Active: Fraction of Cavity Solar Heat Removed (A- Fhr) vs. solar radiation (Ev, Ev > 0.25)

| | |
|---|---|
| Count | 245 |
| Num. Missing | 0 |
| R | .205 |
| R Squared | .042 |
| Adjusted R Squared | .038 |
| RMS Residual | .090 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .087 | .087 | 10.658 | .0013 |
| Residual | 243 | 1.981 | .008 | | |
| Total | 244 | 2.068 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .439 | .023 | .439 | 19.150 | <.0001 |
| Ev | .177 | .054 | .205 | 3.265 | .0013 |

Regression Plot

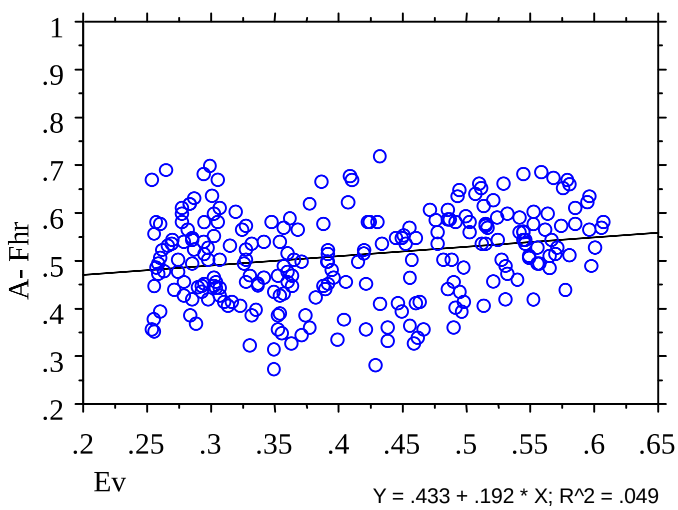



Figure A9 Regression results for the active system: A- Fhr vs. Ev (Ev>0.25)

- Active: Fraction of Cavity Solar Heat Removed (A- Fhr) vs. solar radiation square (Ev^2, Ev > 0.25)

| | |
|---|---|
| Count | 245 |
| Num. Missing | 0 |
| R | .324 |
| R Squared | .105 |
| Adjusted R Squared | .097 |
| RMS Residual | .087 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 2 | .217 | .108 | 14.175 | <.0001 |
| Residual | 242 | 1.851 | .008 | | |
| Total | 244 | 2.068 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .828 | .104 | .828 | 7.965 | <.0001 |
| Ev | -1.827 | .521 | -2.102 | -3.505 | .0005 |
| Ev^2 | 2.412 | .619 | 2.335 | 3.893 | .0001 |

Regression Plot

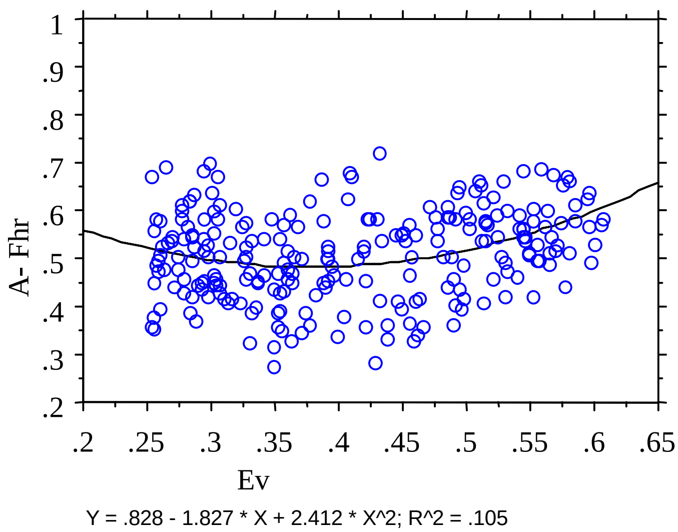



Figure A10 Regression results for the active system: A- Fhr vs. Ev^2 (Ev > 0.25)

- Passive: Fraction of Cavity Solar Heat Removed (P- Fhr) vs. solar radiation (Ev, Ev > 0.25)

| | |
|---|---|
| Count | 245 |
| Num. Missing | 0 |
| \|R\| | .615 |
| R Squared | .378 |
| Adjusted R Squared | .375 |
| RMS Residual | .068 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | .675 | .675 | 147.705 | <.0001 |
| Residual | 243 | 1.111 | .005 | | |
| Total | 244 | 1.786 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .128 | .017 | .128 | 7.456 | <.0001 |
| Ev | .495 | .041 | .615 | 12.153 | <.0001 |

Regression Plot

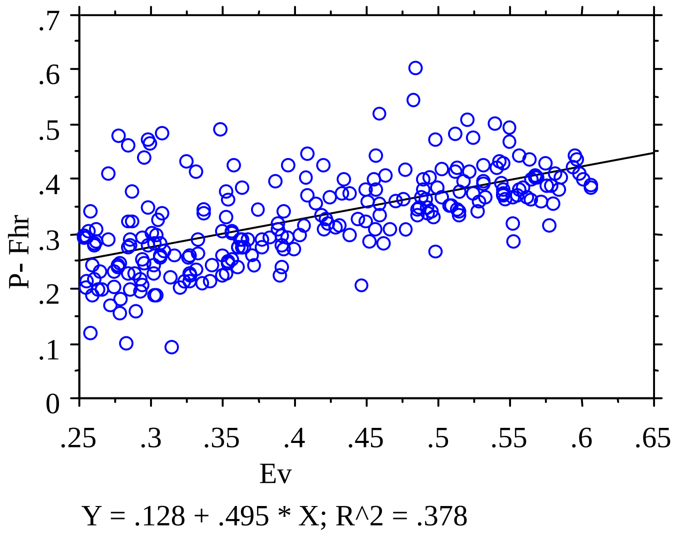



Figure A11 Regression results for the passive system: P- Fhr vs. Ev (Ev > 0.25)

**Appendix G**

Approximate the Relationship Between the Environmental Factors and the Heat Removal Rate

From theoretical expectation, the heat removal rate of the active system should be a function of the vertical solar radiation (Ev.), and outdoor air temperature (OAT).

Active system cavity heat removal rate = fn (Ev, OAT)

And for the passive system, the heat removal rate should be a function of the wind speed (WS), vertical solar radiation (Ev) and outdoor air temperature (OAT).

Passive system cavity heat removal rate = fn (WS, Ev, OAT)

To approximate the relationship between the cavity heat removal rate and environmental factors, first, all of the possible factors were analyzed. According to the ASHRAE Handbook of Fundamentals, "The active and passive systems respectively depend on the forced ventilation and natural ventilation to remove the cavity heat. Forced ventilation, of course, is controlled by the mechanical ventilation equipment. Natural ventilation and infiltration are driven by pressure differences caused by wind, temperature differences between indoor and outdoor air (stack effect), and the operation of appliances, such as combustion devices and mechanical ventilation systems" (ASHRAE, 1997). In the double façade system, the causes of pressure differences will be the wind and the temperature differences between cavity air inlet and outlet. Therefore, the possible variables involved with pressure differences are wind speed, wind direction, vertical solar radiation, and outdoor temperature.

Second, simple regression analysis of the dependent variable (Fhr) vs. each independent variable was performed. This analysis was repeated for both the active and passive system. Based on the regression plot, for both systems, the Fhr and Ev were shown to have a non-linear relationship. A polynomial regression analysis then was performed for these variables (Figure 4.1, 4.2). The remaining regression plots show the fraction of cavity solar heat removed (dependent) and other environmental factors (independent) have a linear relationship. The results of simple regression analyses for all of the variables are reported at Appendix D and E.

The regression plots in Appendix D and E show that the solar radiation and heat removal rate have two response regions. When $Ev < 0.25$, the Ev has a negative relationship with Fhr. When $Ev > 0.25$, the Ev has a positive relationship with Fhr. Low Ev value, $Ev < 0.25$, typically occurs near sun rise and sun set as well as on cloudy days. On the other hand, the Ev values $> 0.25$ are for the clear midday conditions. Therefore, another analysis was performed to obtain the regression results when the solar radiation $> 0.25$ (Appendix F).

For the active system, the regression model shown in Figure A9 ($R^2 = 0.042$) has a lower $R^2$ value than Figure A1 ($R^2 = 0.149$). However, the RMS Residual value in Figure A9

(RMS = 0.090) is smaller than in Figure A1 (RMS = 0.131). This suggests that the model in Figure A9 can, on average, explain the variance in the dependent variable with less uncertainty. Of concern is the apparent possibility of a non-linear relationship in Figure A9. In addition, a non-linear regression analysis was performed (Figure A10). In this polynomial regression, the results show that both $R^2$ and RMS Residual are improved compared to the results in Figure A9. Therefore, Ev^2 is considered as a possible independent variable for determining the heat removal rate of the active system and was used in the following regression analyses.

For passive system, Figure A11 ($R^2$ = 0.378, RMS = 0.068) shows a more reliable regression model than Figure A2 ($R^2$ = 0.055, RMS = 0.097).

Next, a stepwise regression analysis for the fraction of solar heat removed (Fhr) vs. environmental variables (OAT, Ev, WS, WD) was performed. This model selection procedure helps choose the independent variables (OAT, Ev, WS, WD) that are most useful in explaining or predicting the dependent variable (Fhr). The variables for the active system are outdoor air temperature (OAT), vertical solar radiation (Ev), vertical solar radiation square (Ev^2), wind speed (WS), and wind direction (WD). The variables for the passive system are outdoor air temperature (OAT), vertical solar radiation (Ev), wind speed (WS), and wind direction (WD). Figure G and H show the results for both systems.

Stepwise regression summary for the active system

| | |
|---|---|
| F-to-Enter | 4.000 |
| F-to-Remove | 3.996 |
| Number of Steps | 5 |
| Variables Entered | 4 |
| Variables Forced | 0 |
| Stepwise Procedure | Forward |

Regression Summary

| | |
|---|---|
| Count | 250 |
| Num. Missing | 0 |
| \|R\| | .452 |
| R Squared | .204 |
| Adjusted R Squared | .191 |
| RMS Residual | .090 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 4 | .505 | .126 | 15.466 | <.0001 |
| Residual | 245 | 2.000 | .008 | | |
| Total | 249 | 2.505 | | | |

Variables In Model

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .681 | .118 | .681 | 5.781 | <.0001 |
| OAT | .004 | .001 | .272 | 4.609 | <.0001 |
| WS | -.027 | .009 | -.182 | -3.090 | .0022 |
| Ev | -2.234 | .542 | -2.374 | -4.119 | <.0001 |
| Ev^2 | 2.902 | .648 | 2.585 | 4.478 | <.0001 |

Figure A12 Regression results for the active system: fraction of solar heat removed vs. 5 independent variables

For the active system, the four variables, outdoor air temperature (OAT, t = 4.609), wind speed (WS, t = -3.090), vertical solar radiation (Ev, t = -4.119), and vertical solar radiation square (Ev^2, t = 4.478) are shown to be statistically significant. The wind direction is removed from the model.

The regression results show that about 20 % ($R^2 = 0.204$) of the variability of cavity heat removal rate can be explained by this model. The value of the RMS (Residual Mean Square = 0.090) suggests that this model can explain the variability of the active system cavity heat removal rate within ± 9 % on average. Based on the results of the ANOVA test, the F-value is 15.466 ($p < 0.05$), which indicates that the model is statistically significant.

The function of fraction of cavity solar heat removed for active system is approximated by equation 4.7

$$\text{A- Fhr} = 0.681 + 0.004\,(\text{OAT}) - 0.027\,(\text{WS}) - 2.234\,(\text{Ev}) + 2.902\,(\text{Ev})^2 \qquad \text{(A1)}$$

Where: OAT = outdoor air temperature, °F
WS = wind speed, mile/hr
Ev = solar radiation, Btu/h.ft$^2$

The passive system was analyzed in a similar way and the results presented in Figure A13.

Stepwise regression summary for the passive system

| | |
|---|---|
| F-to-Enter | 4.000 |
| F-to-Remove | 3.996 |
| Number of Steps | 4 |
| Variables Entered | 4 |
| Variables Forced | 0 |
| Stepwise Procedure | Forward |

Regression Summary

| | |
|---|---|
| Count | 250 |
| Num. Missing | 0 |
| \|R\| | .740 |
| R Squared | .547 |
| Adjusted R Squared | .542 |
| RMS Residual | .058 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 4 | 1.001 | .250 | 74.832 | <.0001 |
| Residual | 245 | .819 | .003 | | |
| Total | 249 | 1.820 | | | |

Variables In Model

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | .307 | .046 | .307 | 6.662 | <.0001 |
| OAT | -.004 | .001 | -.295 | -6.259 | <.0001 |
| WS | -.007 | .006 | .054 | -5.873 | <.0001 |
| WD | .001 | 7.183E-5 | .390 | 7.737 | <.0001 |
| Ev | .369 | .037 | .460 | 9.955 | <.0001 |

Figure A13 Regression results for passive system: fraction of heat removed vs. 4 independent variables

The four variables, outdoor air temperature (OAT, t = -6.259), wind speed (WS, t = -5.873), wind direction (WD, t = 7.737) and vertical solar radiation (Ev, t = 9.955) are statistically significant.

The regression results show that about 55 % ($R^2$= 0.547) of the variability of cavity heat removal rate can be explained by this model. The value of the RMS (Residual Mean Square = 0.058) is very close to zero, which suggests that this model can explain the variability of the passive system cavity heat removal rate within about ± 6%. Based on the results of the ANOVA test, the F-value is 74.832 ($p < 0.05$), which suggests that the model is statistically significant.

The function of fraction of cavity solar heat removed for the passive system is approximated by Equation 4.8:

$$P\text{- } Fhr = 0.307 - 0.004\,(OAT) - 0.007\,(WS) + 0.001\,(WD) + 0.369\,(Ev) \qquad \text{(A2)}$$

Where: OAT = outdoor air temperature, °F

WS = wind speed, mile/hr

WD = wind direction

Ev = solar radiation, Btu/h.$ft^2$

**Appendix H**
Approximate the Environmental Factors that are Related to the Temperature Difference Between Indoor Glass Surface and Indoor Air

All of the environmental factors, outdoor air temperature (OAT), wind speed (WS), wind direction (WD), and vertical solar radiation (Ev) were included in a stepwise regression analysis to determine the variables that influence the temperature difference between the inside glass surface temperature and the air temperature near the indoor glass pane (ΔTga). The following figures show the stepwise regression results.

Stepwise regression summary for the active system: upper ΔTga

| | |
|---|---|
| F-to-Enter | 4.000 |
| F-to-Remove | 3.996 |
| Number of Steps | 1 |
| Variables Entered | 1 |
| Variables Forced | 0 |
| Stepwise Procedure | Forward |

Regression Summary

| | |
|---|---|
| Count | 257 |
| Num. Missing | 0 |
| R | .964 |
| R Squared | .929 |
| Adjusted R Squared | .928 |
| RMS Residual | .664 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 1 | 1462.896 | 1462.896 | 3322.215 | <.0001 |
| Residual | 255 | 112.286 | .440 | | |
| Total | 256 | 1575.183 | | | |

Variables In Model

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | -1.670 | .112 | -1.670 | -14.935 | <.0001 |
| Ev | 18.344 | .318 | .964 | 57.639 | <.0001 |

Figure A14 Regression results for active system: upper ΔTga vs. 4 independent variables

The vertical solar radiation (Ev, t = 57.639) is statistically significant. The variables outdoor air temperature, wind speed and wind direction are not statistically significant and are removed from the model.

The results show that about 93 % ($R^2$ = 0.929) of the variability of the active system upper ΔTga can be explained by this model. The value of the RMS (Residual Mean Square = 0.664) indicates this model can explain the variability of the active system upper ΔTga within ± 0.7°F on average. Based on the results of the ANOVA test, the F-value is 3322.215 ($p < 0.05$), which suggests that the model is statistically significant.

Stepwise regression summary for the active system: lower ΔTga

| | |
|---|---|
| F-to-Enter | 4.000 |
| F-to-Remove | 3.996 |
| Number of Steps | 2 |
| Variables Entered | 2 |
| Variables Forced | 0 |
| Stepwise Procedure | Forward |

Regression Summary

| | |
|---|---|
| Count | 257 |
| Num. Missing | 0 |
| R | .971 |
| R Squared | .943 |
| Adjusted R Squared | .943 |
| RMS Residual | .761 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 2 | 2458.244 | 1229.122 | 2119.674 | <.0001 |
| Residual | 254 | 147.285 | .580 | | |
| Total | 256 | 2605.529 | | | |

Variables In Model

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | 2.565 | .583 | 2.565 | 4.397 | <.0001 |
| OAT | -.042 | .008 | -.086 | -5.623 | <.0001 |
| Ev | 23.259 | .373 | .950 | 62.320 | <.0001 |

Figure A15 Regression results for active system: lower ΔTga vs. 4 independent variables

The outdoor air temperature (OAT, t = -5.623) and vertical solar radiation (Ev, t = 62.320) are statistically significant. The variables wind speed and wind direction are not statistically significant and are removed from the model.

The results show that about 94 % ($R^2$ = 0.943) of the variability of the active system lower ΔTga can be explained by this model. The value of the RMS (Residual Mean Square = 0.761) indicates this model can explain the variability of the active system lower ΔTga ± 0.8°F on average. Based on the results of the ANOVA test, the F-value is 2119.674 ($p < 0.05$), which suggests that the model is statistically significant.

Stepwise regression summary for the passive system: upper ΔTga

| | |
|---|---|
| F-to-Enter | 4.000 |
| F-to-Remove | 3.996 |
| Number of Steps | 4 |
| Variables Entered | 4 |
| Variables Forced | 0 |
| Stepwise Procedure | Forward |

Regression Summary

| | |
|---|---|
| Count | 257 |
| Num. Missing | 0 |
| \|R\| | .798 |
| R Squared | .636 |
| Adjusted R Squared | .633 |
| RMS Residual | 1.793 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 3 | 3933.039 | 983.260 | 173.714 | <.0001 |
| Residual | 253 | 2247.108 | 5.660 | | |
| Total | 256 | 6180.147 | | | |

Variables In Model

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | -15.364 | 1.368 | -15.364 | -11.232 | <.0001 |
| OAT | .284 | .019 | .478 | 14.953 | <.0001 |
| WS | -.819 | .195 | -.139 | -4.205 | <.0001 |
| WD | -.021 | .002 | -.332 | -9.492 | <.0001 |
| Ev | 20.233 | .878 | .731 | 23.033 | <.0001 |

Figure A16 Regression results for passive system: upper ΔTga vs. 4 independent variables

The outdoor temperature (OAT, t = 14.953), wind speed (WS, t = -4.205), wind direction (WD, t = -9.492) and vertical solar radiation (Ev, t = 23.033) are significantly related to the passive system upper ΔTga.

The results show that about 64 % ($R^2 = 0.636$) of the variability of the passive system upper ΔTga can be explained by this model. The value of the RMS (Residual Mean Square = 1.793) indicates this model can explain the variability of the passive system upper ΔTga within ± 1.8°F on average. Based on the results of the ANOVA test, the F-value is 173.714 ($p < 0.05$), which suggests that the model is statistically significant.

Stepwise regression summary for the passive system: lower ΔTga

| | |
|---|---|
| F-to-Enter | 4.000 |
| F-to-Remove | 3.996 |
| Number of Steps | 4 |
| Variables Entered | 4 |
| Variables Forced | 0 |
| Stepwise Procedure | Forward |

Regression Summary

| | |
|---|---|
| Count | 257 |
| Num. Missing | 0 |
| R | .673 |
| R Squared | .453 |
| Adjusted R Squared | .444 |
| RMS Residual | 1.607 |

ANOVA Table

| | DF | Sum of Squares | Mean Square | F-Value | P-Value |
|---|---|---|---|---|---|
| Regression | 4 | 537.971 | 134.493 | 52.109 | <.0001 |
| Residual | 252 | 650.404 | 2.581 | | |
| Total | 256 | 1188.375 | | | |

Regression Coefficients

| | Coefficient | Std. Error | Std. Coeff. | t-Value | P-Value |
|---|---|---|---|---|---|
| Intercept | -16.312 | 1.387 | -16.312 | -11.764 | <.0001 |
| OAT | .246 | .019 | .737 | 12.990 | <.0001 |
| WS | 1.254 | .180 | .350 | 6.965 | <.0001 |
| WD | -.008 | .002 | -.237 | -4.031 | <.0001 |
| Ev | 4.052 | .851 | .245 | 4.762 | <.0001 |

Figure A17 Regression results for passive system: lower ΔTga vs. 4 independent variables

The variables outdoor temperature (OAT, t = 12.990), wind speed (WS, t = 6.965), wind direction (WD, t = -4.031) and vertical solar radiation (Ev, t = 4.762) are significantly related to the passive system lower ΔTga.

The results show that about 45 % ($R^2$ = 0.453) of the variability of the passive system lower ΔTga can be explained by this model. The value of the RMS (Residual Mean Square = 1.607) indicates this model can explain the variability of the passive system lower ΔTga within ± 1.61°F on average. Based on the results of the ANOVA test, the F-value is 52.109 ($p < 0.05$), which suggests that the model is statistically significant.

# VITA
# Shang-Shiou Li

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| | |
|---|---|
| 1998-2001 | Master of Science in Architecture<br>Department of Architecture & Urban Studies<br>Virginia Polytechnic Institute & State University |
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**Experience**

| | |
|---|---|
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**Publication/Graduate Research**

1999 Experimental Study of the Cooling Season Performance of Ventilation Double-Glass Envelope Cavities, Jim Jones, Tahar Messadi, Shang-Shiou Li

- International Building Physics Conference, Tools for Design and Engineering of Buildings