CMGT 235 – Mechanical and Electrical Systems

Homework #2 – Calculating Heat Loss in Buildings

Due: 8/30

Solution

**Name**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Calculate the total heat loss due to transmission during a 24-hour period for a flat roof 90 ft X 135 ft. The roof is constructed per the detail below. The inside temperature is 70 °F and the outside temperature is 52 °F. Assume winter conditions. Show all calculations.

A picture containing diagram

Description automatically generated

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | R (Between joist) | R (At joist) |
| 1. | Air film outside | 0.17 | 0.17 |
| 2. | 3/8 in. Built-up roofing | 0.33 | 0.33 |
| 3. | 5/8 in. Plywood Sheathing | 0.77 | 0.77 |
| 4. | 1 ½ in. Air space | 1.00 | --- |
| 5. | R-15 Fiberglass Batt Insulation | 15.00 | --- |
| 6. | 5/8 in. Gypsum board | 0.56 | 0.56 |
| 7. | Air film inside | 0.68 | 0.68 |
| 8. | Nominal 2-in x 12-in Doug Fir Joist @ 24 in. o.c. . (1.5” x 11.25”) R=1.00 | --- | 11.25 |
| RTotal | | 18.51 | 13.76 |
| RTotal (Average) | | 18.21 | |
| U-Factor (Use Three Decimals) | | 0.055 | |

Determine the average U-Factor for the ceiling

22.5”

1.5”

RAVG = (1.5”/24”) x 13.76 + (22.5”/24”) x 18.51 = 0.86 + 17.35 = 18.21

UAVG = 1 / RAVG = 1 / 18.21 = 0.055 Btu/hr x °F x ft2

Total Heat Loss

Q = U x A x ∆T x 24 hr = 0.055 Btu/hr x °F x ft2 x (90 ft x 135 ft) x (70°F - 52°F) x 24 hr = 12,029 BTU

1. An exterior wall is made up of 8" of stone (R= 0.08 per inch), 3" of foamed-in-place polyurethane, and 0.75" Plywood, and 5/8" gypsum board. Determine the total R-value and U-Factor for the wall. Use the lookup table provided in class. Assume winter.

|  |  |
| --- | --- |
| Component | R-Value |
| Wall – Outside Air Film | 0.17 |
| 8" stone | 0.64 |
| 3" foamed-in-place polyurethane | 18.75 |
| ¾" plywood | 0.93 |
| 5/8" gypsum board | 0.56 |
| Inside Air Film | 0.68 |
| Total Wall Assembly R-Value | 21.73 |
| U-Factor (Use Three Decimals) | 0.046 |

1. If the wall in problem 2 is 40 ft long and 12 ft. high what is the heat loss through the wall for an indoor winter design temperature of 78 °F and an outside temperature of 42°F?

Rate of Heat Loss

q = U x A x ∆T = 0.046 Btu/hr x °F x ft2 x (40 ft x 12 ft) x (78 °F - 42°F) = 795 Btuh

Heat loss per Day

Q = U x A x ∆T = 0.046 Btu/hr x °F x ft2 x (40 ft x 12 ft) x (78 °F - 42°F) x 24 hr = 19,080 Btu