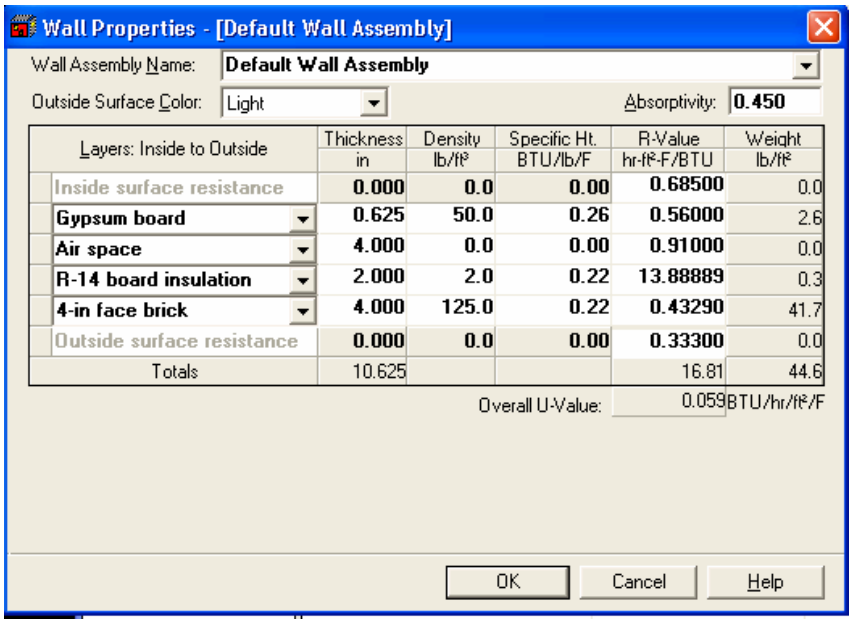
Breadth Study

Thermal Gradient

Because the new design for the Upper Campus Housing Project will allow for less shear walls, a new exterior envelope will need to be constructed to fill in the voids between the remaining shear walls. This new curtain wall will consist of an exterior brick façade with a light gauge metal stud back up. For each material in the new wall construction a U-Factor and an R-Value were calculated. The R-Value, the thermal resistance, and the U-Factor, the solar heat gain coefficient, values were taken from the Carrier's Hourly Analysis Program. The following chart is the output from that program:



From the information given from Carrier's Hourly Analysis Program the following Excel spreadsheet was constructed to calculate the change in temperature through each material:

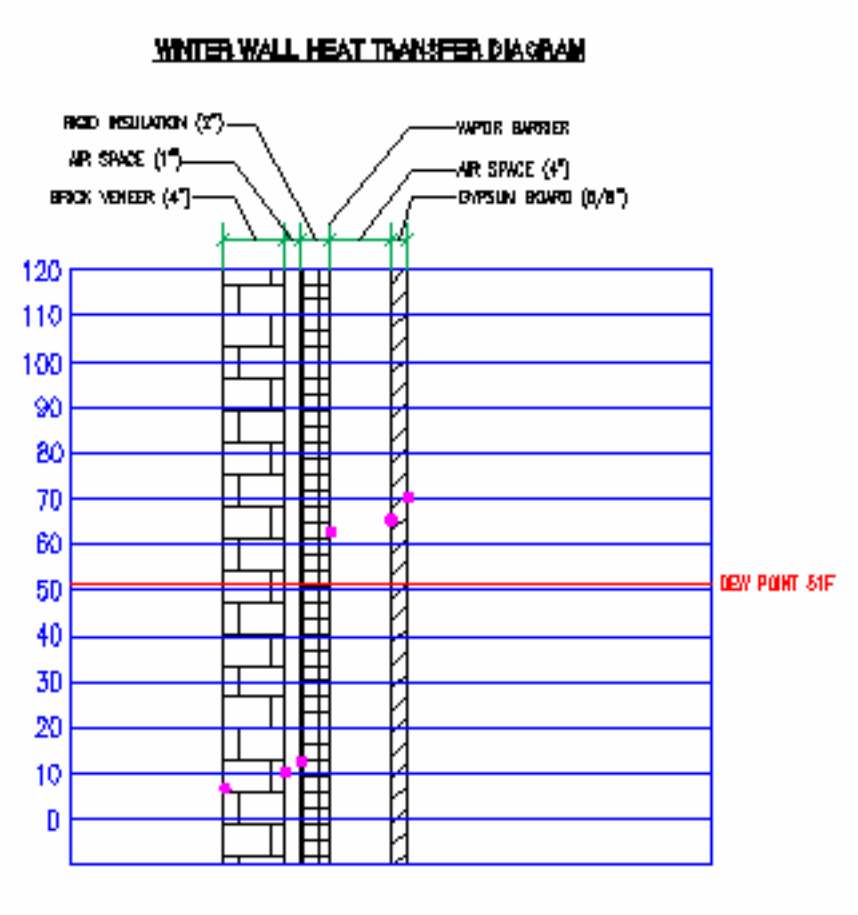
Material	Thickness (in)	R-Value	ΔT	
			Winter	Summer
Outside Air SR	0.00	0.33	1.184	0.207
4" Brick Veneer	4.00	0.43	1.539	0.269
Air Space	1.00	0.91	3.235	0.565
Board Insulation	2.00	13.89	49.381	8.622
Vapor Barrier	0.01	0.00	0.000	0.000
Air Space	3.50	0.91	3.235	0.565
GWB	0.63	0.56	1.991	0.348
Inside Air	0.00	0.69	2.435	0.425
Totals	11.14	17.72		

The entire spreadsheet can be viewed in Appendix page 105.

The information used to construct the spreadsheet came from various places. The dew point temperatures came from a psych chart based on 50% Relative Humidity and 75F for summer and 70F for winter. Therefore, the dew point temperatures are 55F for summer and 51F for winter. The maximum allowable U-Factor was determined from the ASHRAE std. 90.1-2004 (Appendix page 106). This maximum U-Factor is equal to 0.064. The outdoor design conditions came from the ASHRAE Design Handbook of Fundamentals 1993. This handbook states that for Pittsburgh, PA the summer outdoor condition is 86F and the winter outdoor condition is 7F.

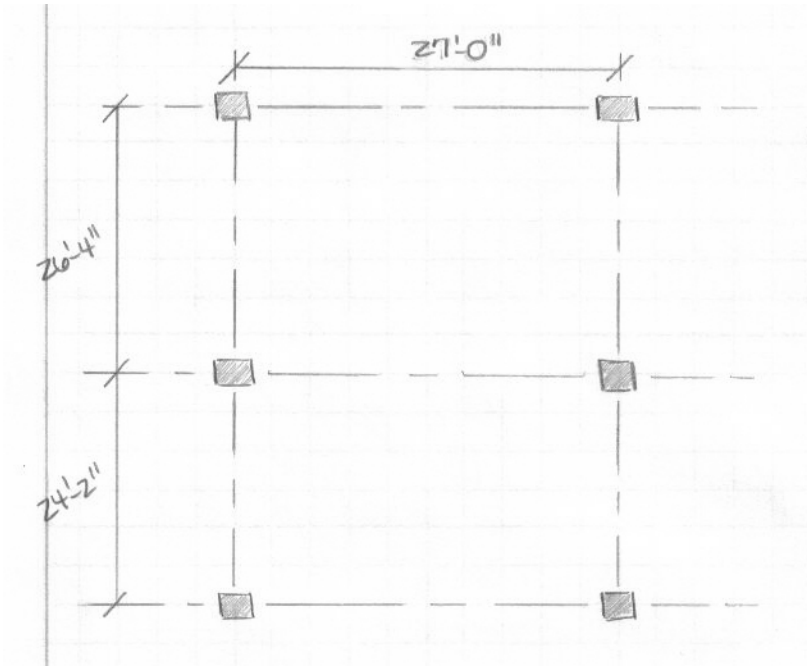
After the temperature changes were determined a wall section thermal gradient was constructed to determine where the water vapor would condense in each wall section.

In this case, the winter condition controls and tells us where to locate the vapor barrier in the wall section. Below is the thermal gradient for the winter condition. The summer condition can be viewed in the Appendix page 107.



Construction Management Issues

Construction management issues, such as cost and duration, are important to be considered when decided which type of structure is best for each project. For the purposes of this report each system the cost and duration of a typical bay was computed using the ICE 2000 program. An example of a typical bay for the flat-plate system is shown below. The typical bay for the one-way plank system is similar. However, it has walls along each horizontal column line instead of columns. Because of the complexity of the flat-plate system the cost and duration are about double of that of the one-way. The one-way system allows for much easier construction, which therefore allows for much less labor. The two-way system has much more labor because the slab and columns need to be formed and the reinforcement must be placed to the exact specifications of the engineer. A summary of the material and labor costs for each system is shown on the next page.



Cost and Duration System Summaries

Two-Way Flat-Plate System	
Material Cost	$11,967
Labor Cost	$7,305
Labor Fringes	$2,004
Equipment Cost	$837
Total	$22,113
Manhours	353

One-Way Plank System	
Material Cost	$8,091
Labor Cost	$1,815
Labor Fringes	$887
Equipment Cost	$265
Total	$11,058
Manhours	92