Energy Balance Report

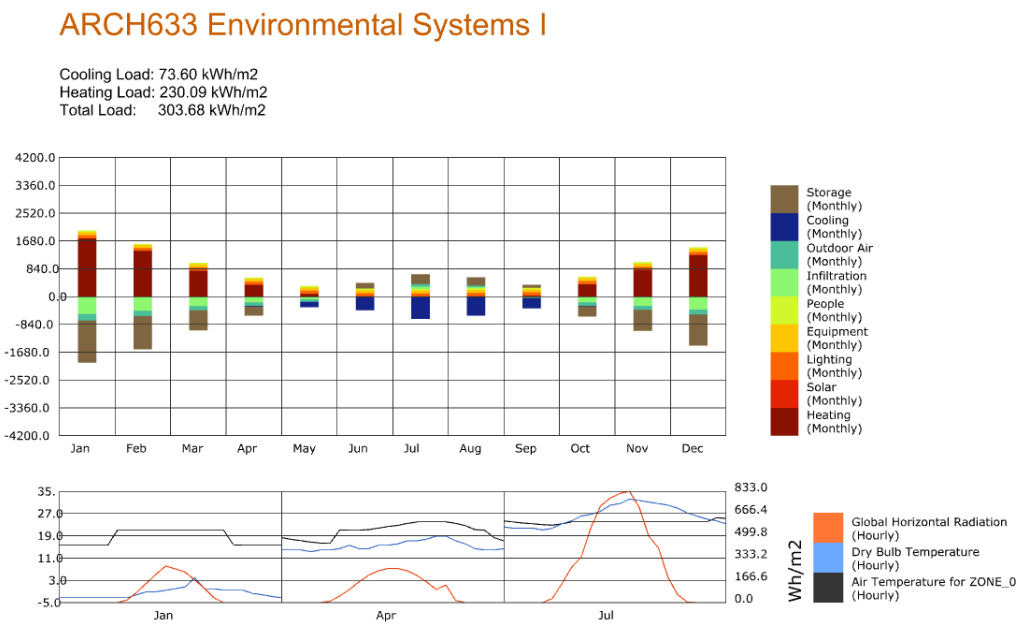
STEP 1: WALL TO WINDOW

In the first step, I will try to explore the effect of wall to window ratio.

Firstly I set all the four ratios to zero. When there are no windows in the building, the energy balance is shown as following.

Parameters:

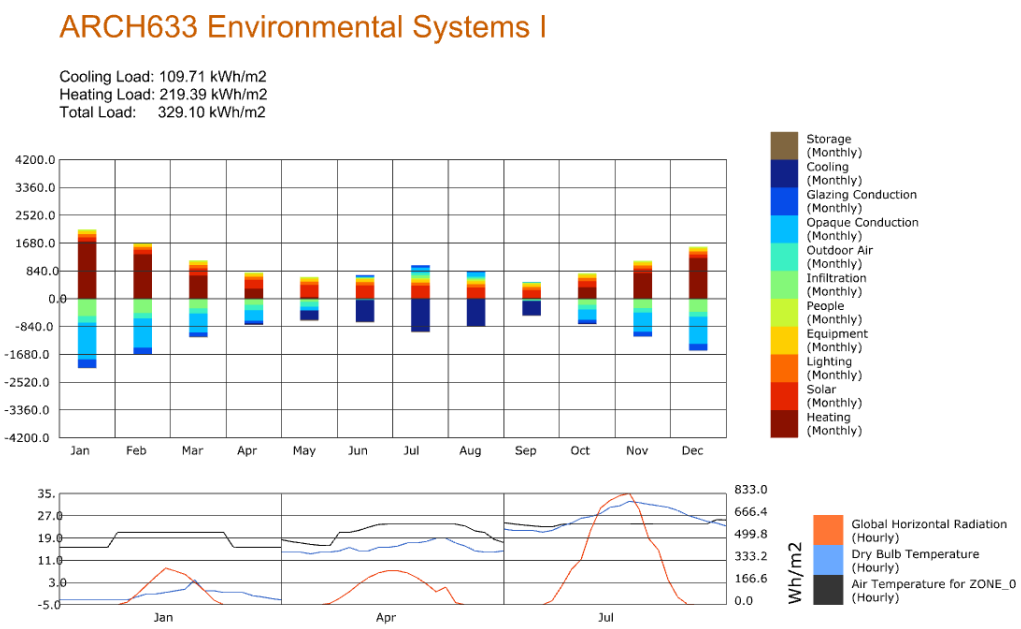
Wall to Window	0,0,0,0
Blinds	false
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True



Secondly, keeping all the other parameters the same, I changed the wall to window ratio – North to 0.5. The energy balance is shown as following.

Parameters:

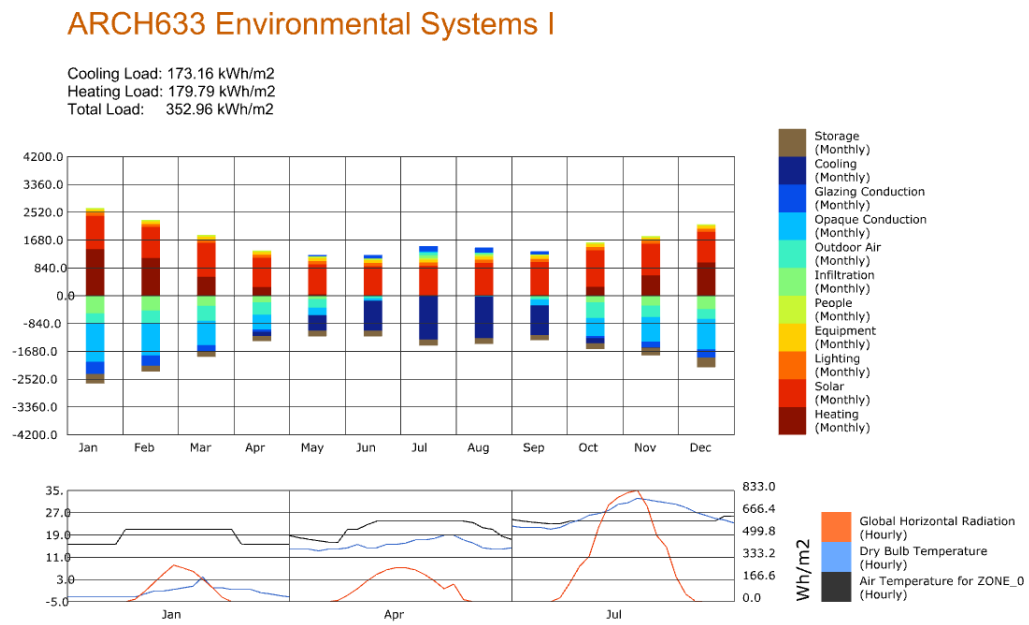
Wall to Window	North:0.5, West:0,South:0,East:0
Blinds	false
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True



Thirdly, keeping all the other parameters the same, I changed the wall to window ratio – North to 0.5. The energy balance is shown as following.

Parameters:

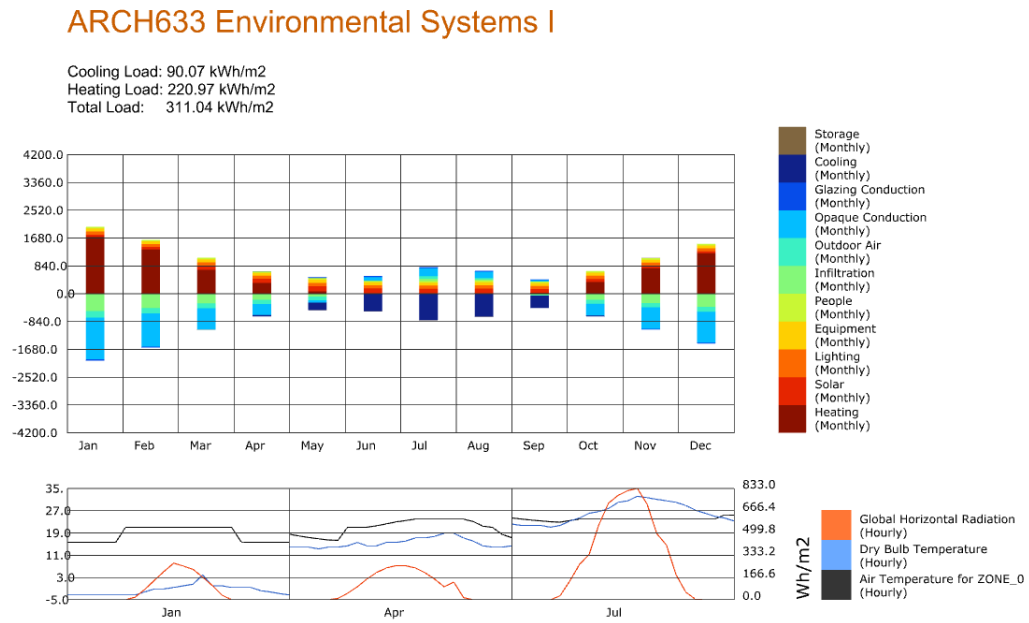
Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	false
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True



Fourthly, after returning all the other parameters back to the beginning, I changed the wall to window ratio – West to 0.5. The energy balance is shown as following.

Parameters:

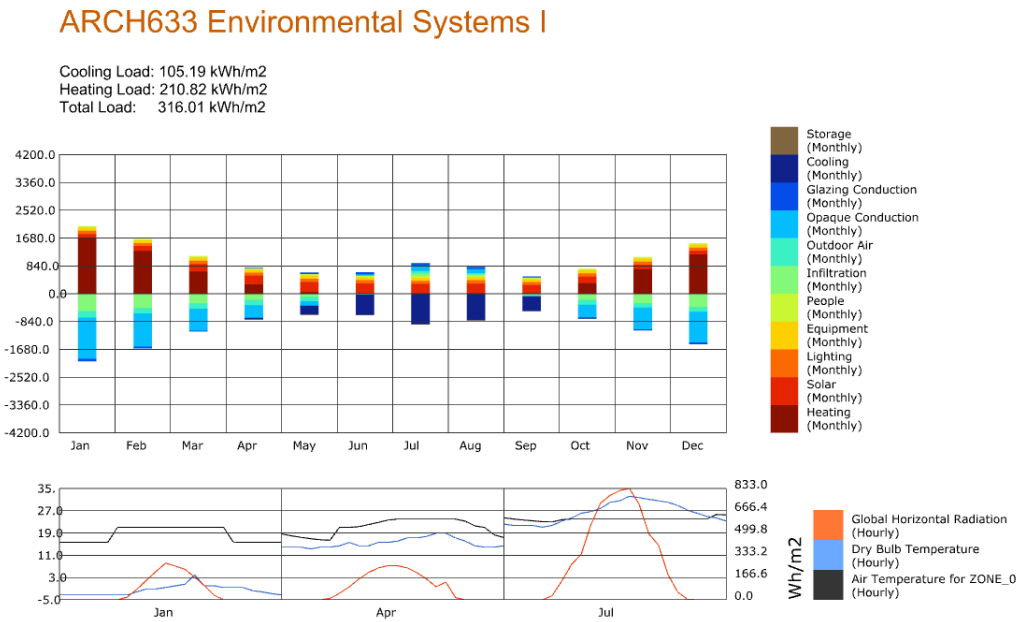
Wall to Window	North:0, West:0.5,South:0,East:0
Blinds	false
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True



Fifthly, I changed both the wall to window ratio – West and East to 0.5. The energy balance is shown as following.

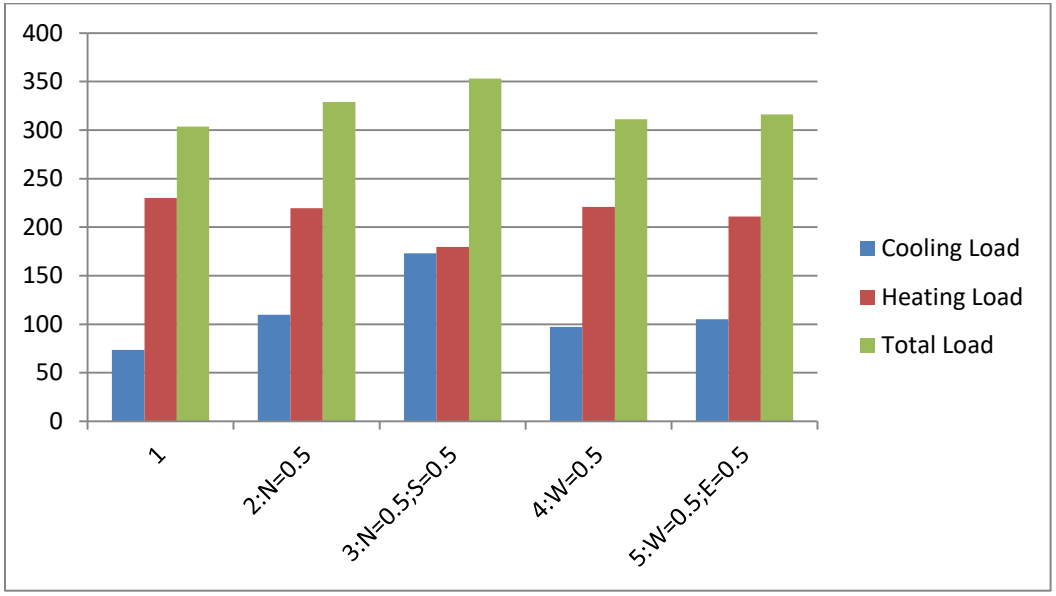
Parameters:

Wall to Window	North:0, West:0.5,South:0,East:0.5
Blinds	false
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True



Data Analysis:

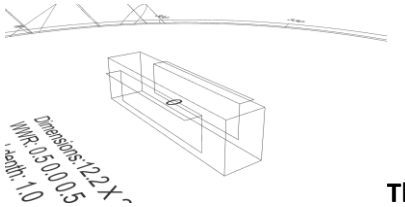
	1	2:N=0.5	3:N=0.5;S=0.5	4:W=0.5	5:W=0.5;E=0.5
Cooling Load	73.6	109.71	173.16	97.07	105.19
Heating Load	230.09	219.39	179.79	220.97	210.82
Total Load	303.68	329.1	352.96	311.04	316.01



Compared with the building without windows, the installation of windows (all the four different situations) decreased heating load but increased cooling load and the total loads were all increased. Comparing the four different types, the third one (N=0.5;S=0.5) has the most significant effect in decreasing heating load and at the same time increasing cooling load. And the third one (N=0.5;S=0.5) has the highest total load. In conclusion, the cross ventilation in North and South has the most obvious effect in changing heating and cooling load. We can find that the installation of windows can work well in decreasing heating load but not in cooling load. We need to find some solutions to decrease cooling loads when installing the windows.

STEP 2.1: BLIND Depth

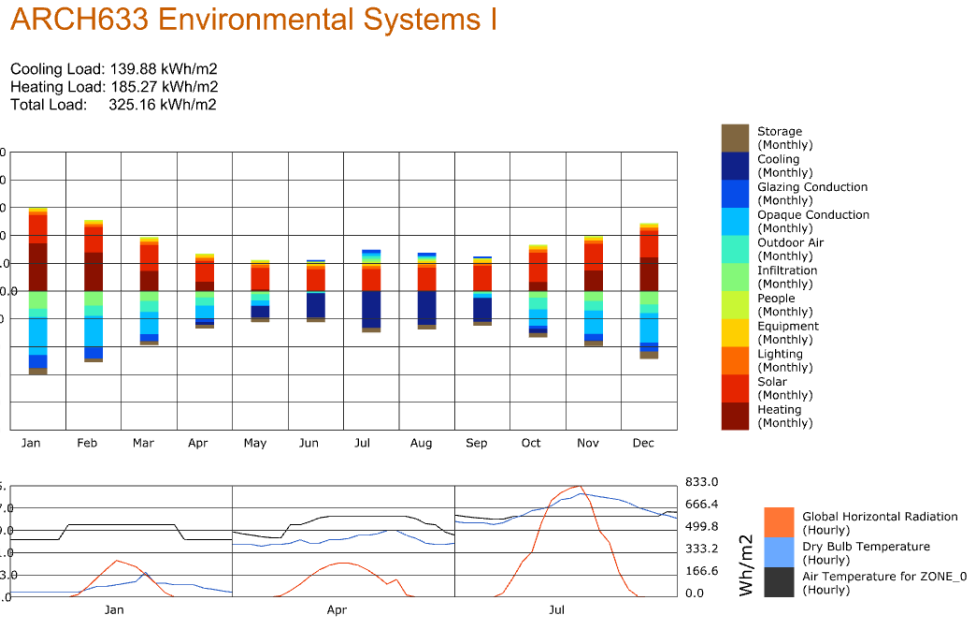
In the second step, I will try to explore the effect of blinds.

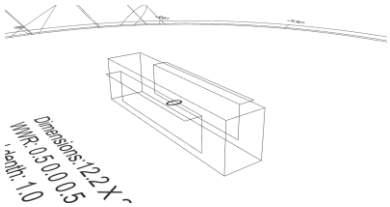


The first type has one blind with depth of 0.6 meters.

Parameters:

Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 1
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True





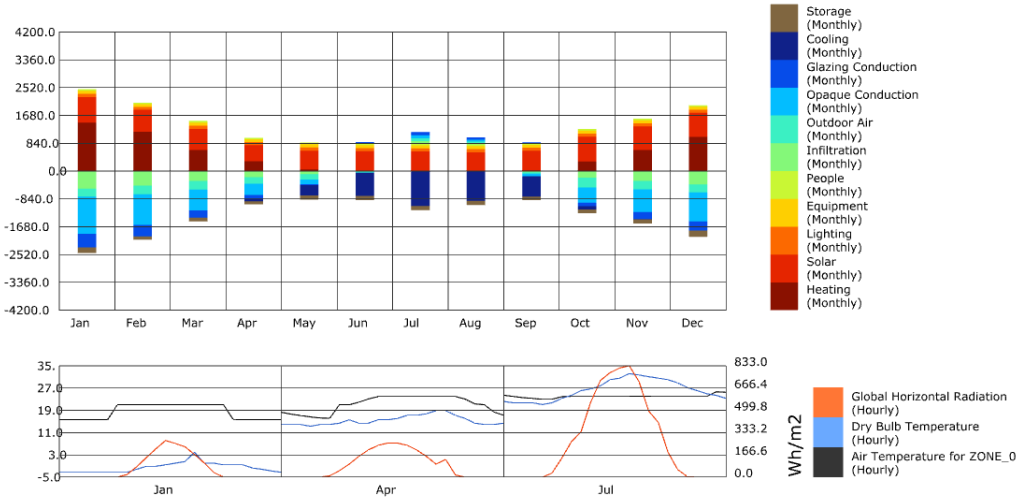
The second type has one blind with depth of 1 meters.

Parameters:

Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:1; number = 1
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True

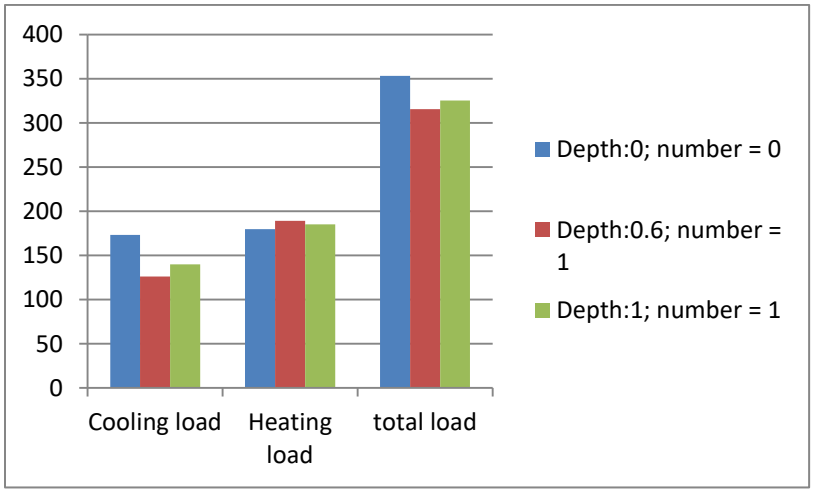
ARCH633 Environmental Systems I

Cooling Load: 126.11 kWh/m2
Heating Load: 189.20 kWh/m2
Total Load: 315.31 kWh/m2



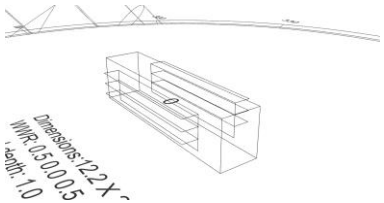
Data Analysis:

Wall to Window	North:0.5, West:0,South:0.5,East:0	Cooling load	Heating load	total load
Blinds	Depth:0; number = 0	173.16	179.79	352.96
Blinds	Depth:0.6; number = 1	126.11	189.2	315.31
Blinds	Depth:1; number = 1	139.88	185.27	325.16



In all the different types of the blind depth, the blind of 0.6m depth works best in decreasing total loads. By adding blinds, the cooling load decreased a lot and heating loads increased and the total load decreased a lot. The first analysis concluded that the installation of windows in North and South (ratio = 0.5) can work well as long as the cooling load can be decreased better. The installation of blinds just can solve this problem. Thus the next step is to increase the numbers of blinds.

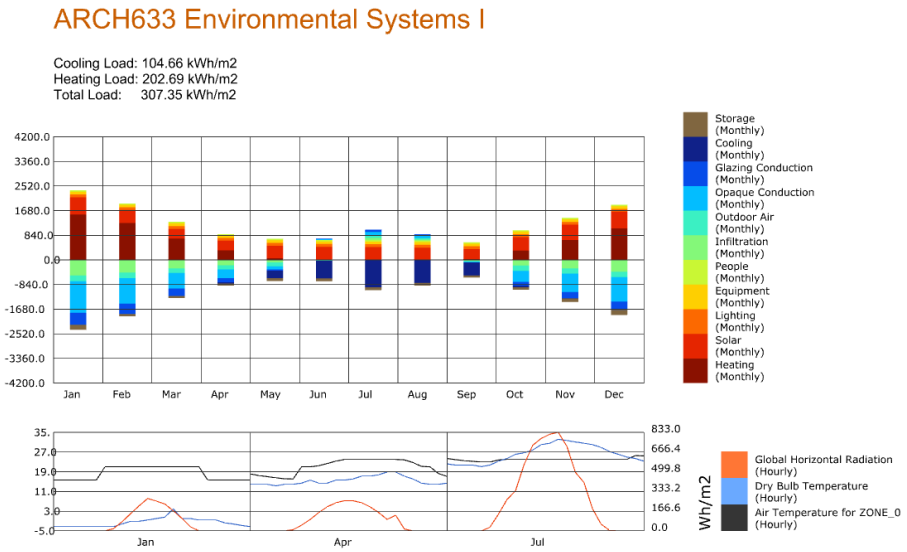
STEP 2.2: BLIND Numbers

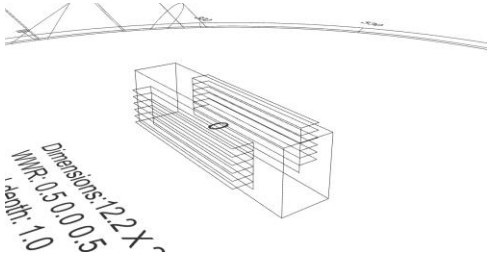


In the exploration of the effects of blind numbers, the first type has 3 blinds with depth of 0.6 meters.

Parameters:

Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 3
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True





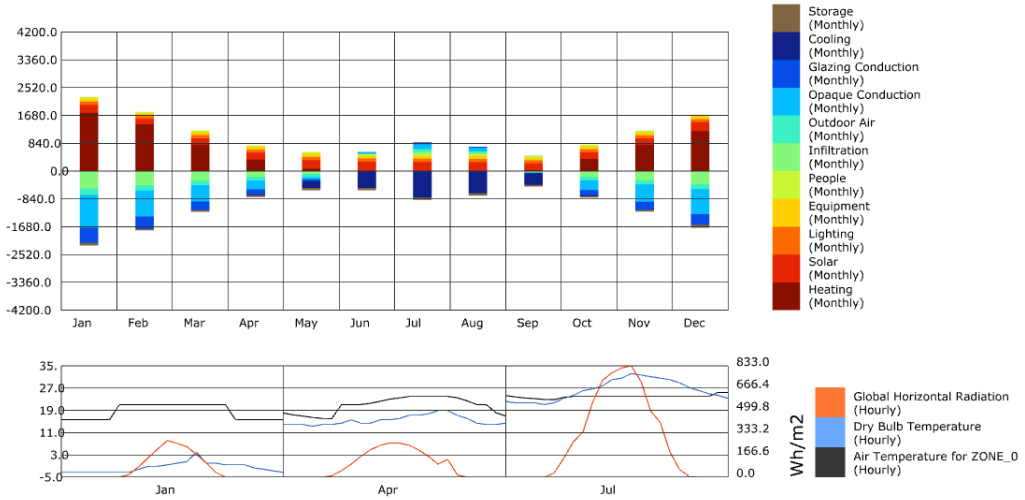
the second type has 6 blinds with depth of 0.6 meters.

Parameters:

Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 6
Construction	R5.5, R0.7, R9.2, 2
Thermal Mass	Existing slab construction
Add system:	True

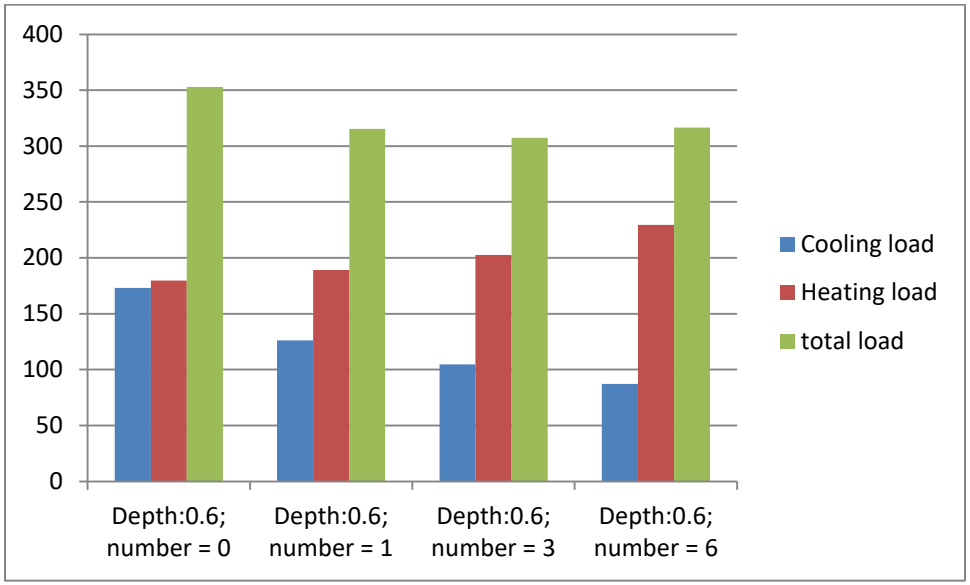
ARCH633 Environmental Systems I

Cooling Load: 87.08 kWh/m2
Heating Load: 229.39 kWh/m2
Total Load: 316.47 kWh/m2



Data Analysis:

Wall to Window	North:0.5, West:0,South:0.5,East:0	Cooling load	Heating load	total load
Blinds	Depth:0.6; number = 0	173.16	179.79	352.96
Blinds	Depth:0.6; number = 1	126.11	189.2	315.31
Blinds	Depth:0.6; number = 3	104.66	202.69	307.35
Blinds	Depth:0.6; number = 6	87.08	229.39	316.47



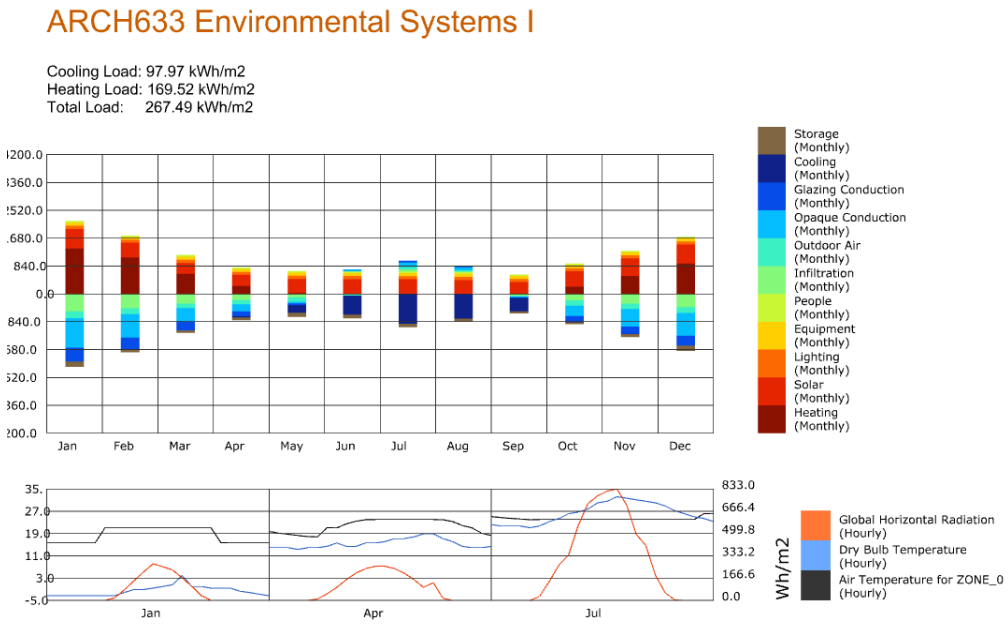
As the number of blinds increased, the cooling heat decreased and heating load increased. When the number of blind is three, the total load is the lowest. From the graph, we can see that the opaque conduction, infiltration and glazing conduction should be decreased in cooling loads and heating and solar loads should be decreased in heating loads. So the next step is to add the R value of exterior wall, exterior window and exterior roof.

STEP 3: Construction

Firstly, I tried to add R-value of wall from 5.5 to 8.7, and the effect is significant:

Parameters:

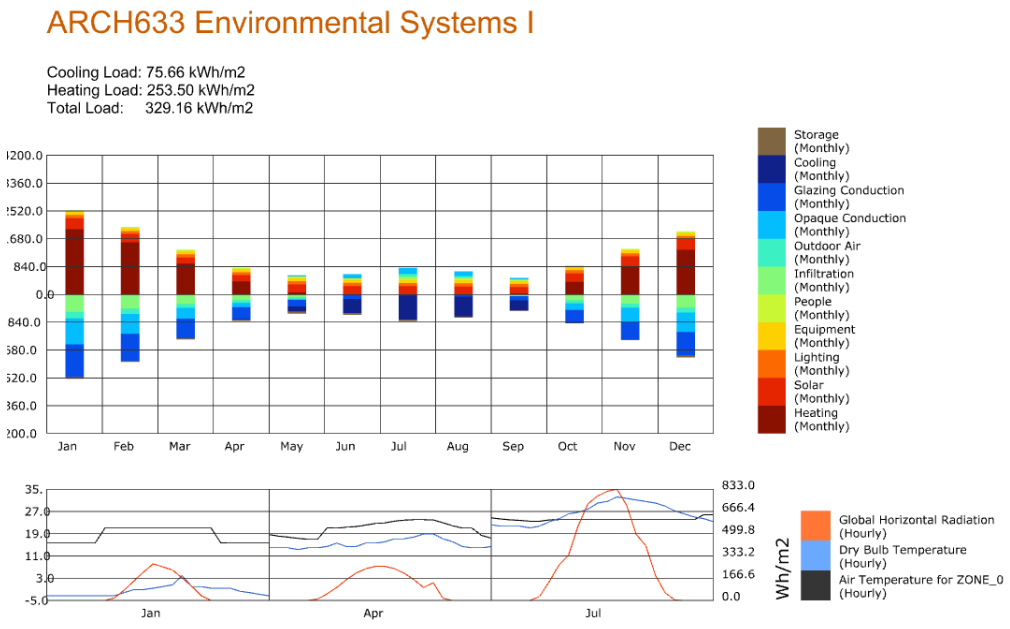
Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 3
Construction	Wall:R8.7, Window:R0.7, Roof: R9.2, air changehour:2
Thermal Mass	Existing slab construction
Add system:	True



Secondly, I also tried to add R-value of window from 0.7 to 1.7, but the total loads increased:

Parameters:

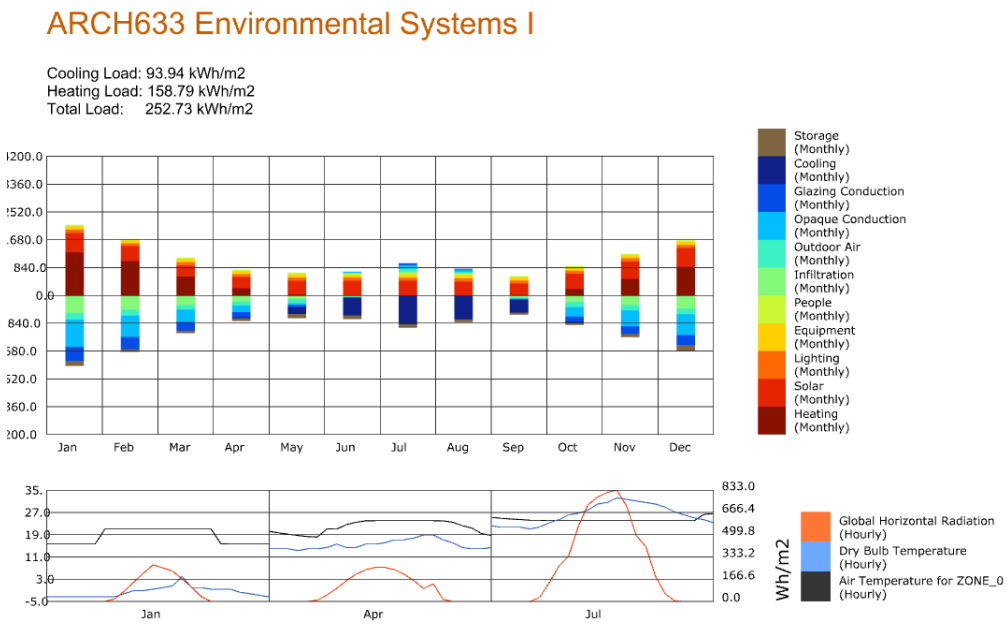
Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 3
Construction	Wall:R8.7, Window:R1.7, Roof: R9.2, air changehour:2
Thermal Mass	Existing slab construction
Add system:	True



Thirdly, I tried to add R-value of roof from 9.2 to 14.8, but the effect is good:

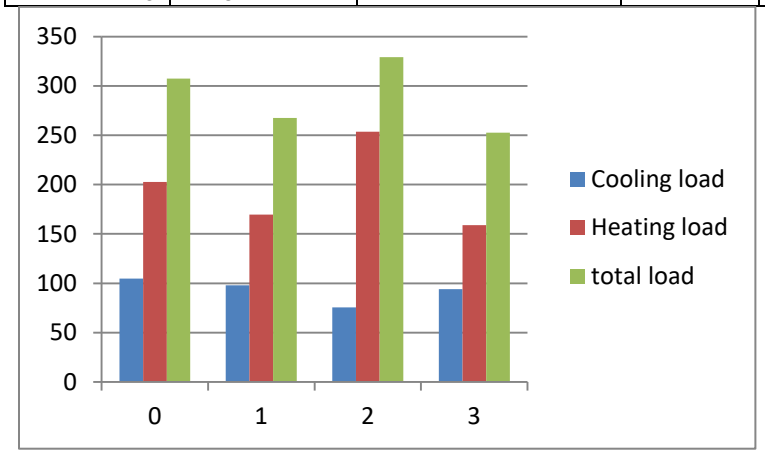
Parameters:

Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 3
Construction	Wall:R8.7, Window:R0.7, Roof: R14.8, air changehour:2
Thermal Mass	Existing slab construction
Add system:	True



DATA Analysis:

construction	roof	window	wall	Cooling load	Heating load	total load
0	R9.2	R0.7, SHGC 0.65	R5.5	104.66	202.69	307.35
1	R9.2	R0.7, SHGC 0.65	R8.7	97.97	169.52	267.49
2	R9.2	R1.7, SHGC 0.39	R8.7	75.66	253.5	329.16
3	R14.8	R0.7, SHGC 0.65	R8.7	93.94	158.79	252.73



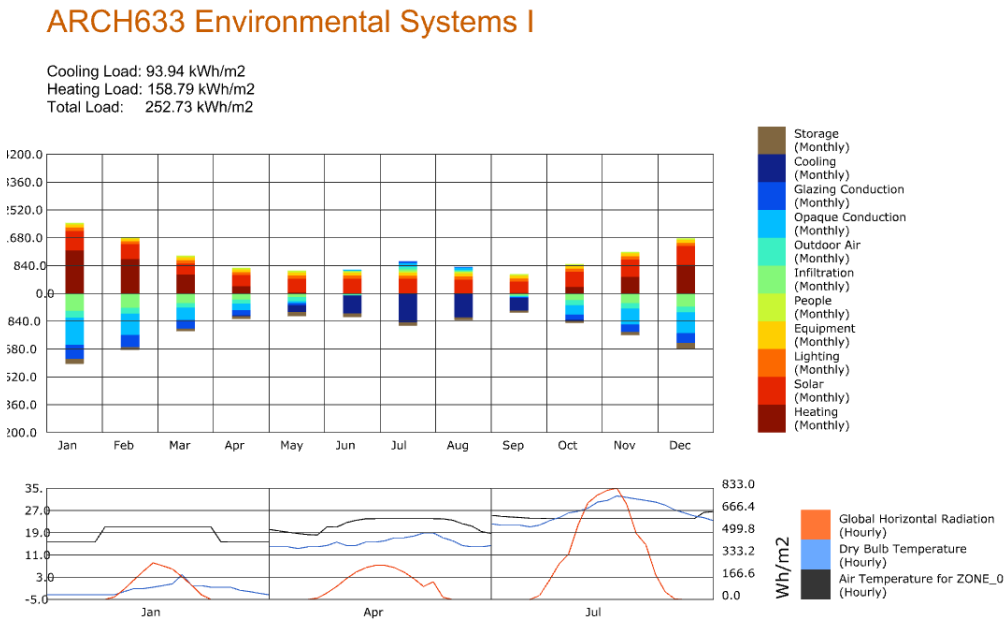
In conclusion, the increase of R-value of roof and wall work well in decreasing the total loads. The type 3 works the best in total loads.

STEP 4: Thermal Mass

In the last step, I will try to explore the effect of thermal mass.

Parameters:

Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 3
Construction	Wall:R8.7, Window:R0.7, Roof: R14.8, air changehour:2
Thermal Mass	+8 inches concrete
Add system:	True



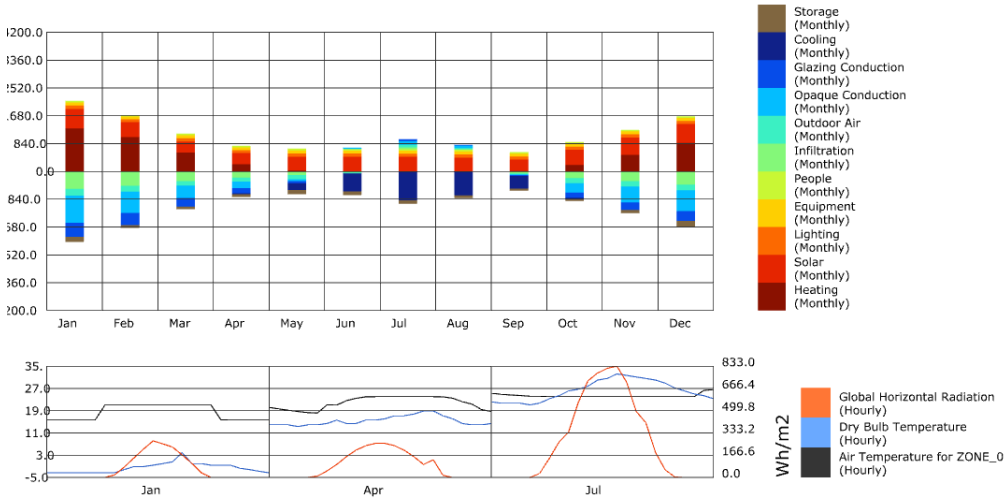
Although I changed the thermal mass from

Parameters:

Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 3
Construction	Wall:R8.7, Window:R0.7, Roof: R14.8, air changehour:2
Thermal Mass	+4 inches concrete
Add system:	True

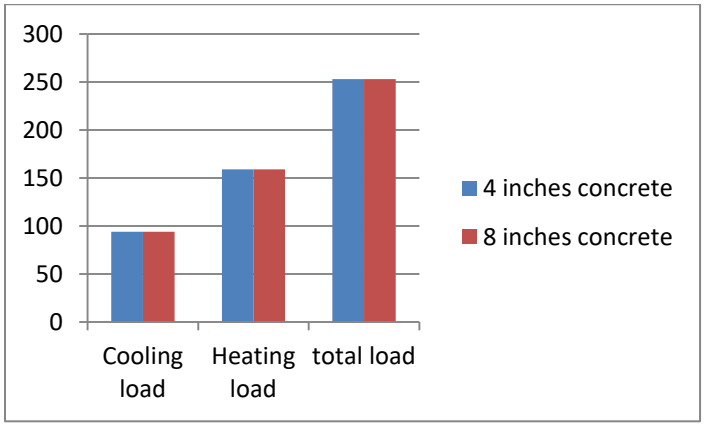
ARCH633 Environmental Systems I

Cooling Load: 93.94 kWh/m2
Heating Load: 158.79 kWh/m2
Total Load: 252.73 kWh/m2



Data Analysis:

	Cooling load	Heating load	total load
4 inches concrete	93.94	158.79	252.73
8 inches concrete	93.94	158.79	252.73



There is no difference in total loads when changing thermal mass.

DISCUSSION:

1. **Which parameter(s) is/are the most effective?**
   Construction

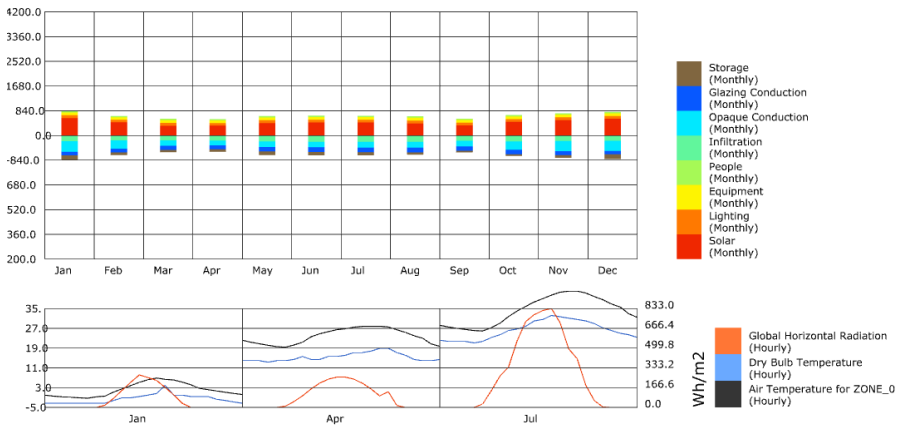
2. What is the temperature range inside the container in summer and winter with no systems after applying all your changes?

When there is no system, the graph is like the following:

Parameters:

Wall to Window	North:0.5, West:0,South:0.5,East:0
Blinds	Depth:0.6; number = 3
Construction	Wall:R8.7, Window:R0.7, Roof: R14.8, air changehour:2
Thermal Mass	+4 inches concrete
Add system:	No

ARCH633 Environmental Systems I



In summer the air temperature range is from 27 to 43 degree Celsius; and in winter, the air temperature is from -1 to 6 degree Celsius.