MEBS6006 Environmental Services I

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Exercises on Thermal Comfort, Load and Energy Calculations

1. (a) Briefly describe the heat balance equation for assessing thermal comfort and its parameters. Apart from heat balance, what is the other condition necessary to ensure thermal comfort?

   (b) Explain the meaning of the following environmental indices commonly used for evaluating the perception of thermal comfort.

   i) Mean radiant temperature

   ii) Operative temperature

   iii) Effective temperature

   iv) Equivalent temperature

2. (a) Briefly explain the meaning of the following terms for cooling load principles.

   i) Space heat gain
   ii) Space cooling load
   iii) Space heat extraction rate
   iv) Cooling coil load

   What are the major components of space cooling load? Which components could have a latent part?

   (b) Draw a summer air conditioning cycle on a psychrometric chart using the following conditions. Illustrate on the chart the important components of the cooling coil load. What is the sensible heat ratio of the space cooling process?

   - Outdoor air at dry-bulb temperature 33 ^{o}C and wet-bulb temperature 28 ^{o}C
   - Room air at dry-bulb temperature 25 ^{o}C and relative humidity 50%
   - Supply air at dry-bulb temperature 14 ^{o}C and relative humidity 85%
   - Supply fan and duct heat gain is assumed 1.5 ^{o}C
   - Return plenum and duct heat gain is assumed 1.5 ^{o}C
   - Outdoor air flow rate = 20 l/s and return air flow rate = 80 l/s

3. (a) Briefly explain the meaning of "sol-air temperature" and the equation to express and calculate it.

What are the <u>three</u> components of Transfer Function Method (TFM)? Show them on a simple diagram of cooling load principles.

(b) Load and energy calculations were performed for an office building using a building energy simulation program. The annual energy use for a reference case and a low-energy case is shown on Figure 1.

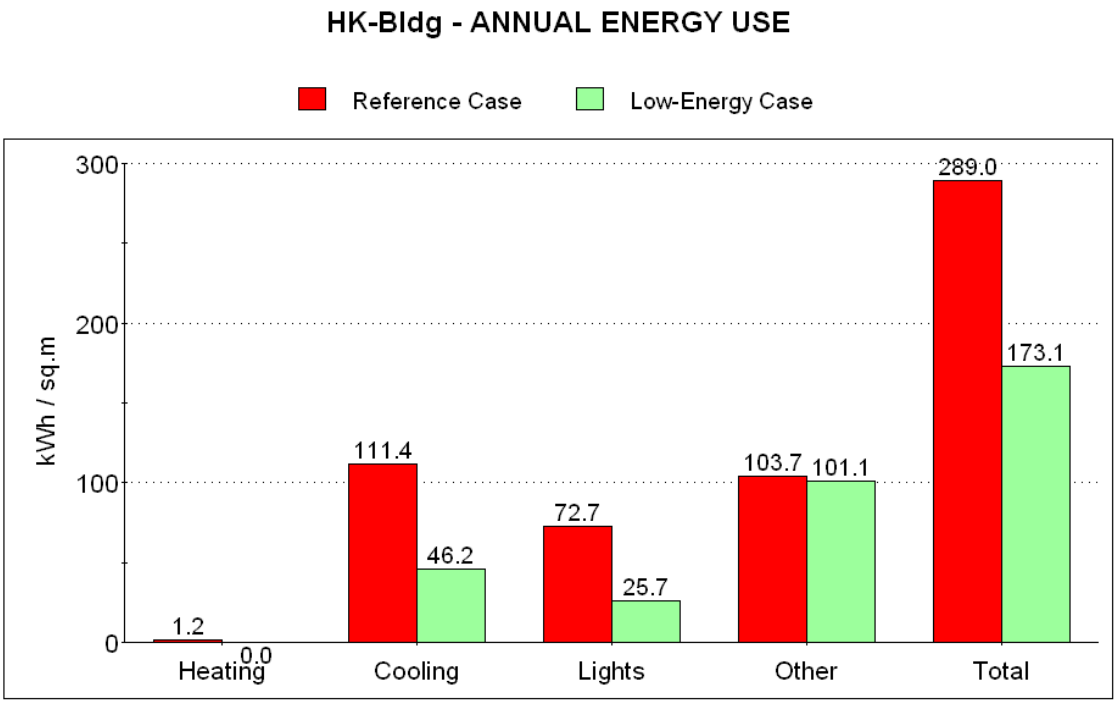

Figure 1.

If the total floor area of the building is 500 m^2, determine the followings:

i) Annual energy saving of the low energy case (in kWh).
ii) Amount of the energy saving obtained from "cooling" and "lights", respectively (in kWh).

The load estimation indicates that the peak design cooling loads for reference case and low-energy case are 44 kW and 28 kW, respectively. Calculate the load density (in m^2/kW) of the peak design cooling loads for each case.

The 24-hour cooling load profiles of the two cases have also been analysed. Briefly explain the important factors affecting the characteristics of the load profiles. If the HVAC system of the building is shut down at night time, what could happen to the cooling load when the system starts to operate in the morning of the next day.