SIMULATION THE EFFECT OF SHAPE AND ORIENTATION ON ENERGY PERFORMANCE FOR RESIDENTIAL BUILDING IN KIRKUK

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Abstract:-In this paper Simulation was done by varying aspect ratio and shape in residential building in Kirkuk city .Preparation the weather data of Kirkuk climate as requirements of simulation residential building with net area 135.2m^2 irregular shape was taken. Four states of aspect ratio (1:1,1:1.25,1:1.5,1:2) was chosen which represent the shape of building &rotate each state to eight orientation (north, north east ,east ,south east ,south ,south west ,west, north west).The results shows that the square shape of building (aspect ratio 1:1) is more energy efficient than other aspect ratio &specially when pointing the building to west orientation and the saving in annual energy is about 10% from the value of consume annual energy with aspect ratio (1:2) in north direction and this efficiency decreases with increasing aspect ratio.

Key-words:- Aspect ratio, Shape, Orientation, Energy performance of building, Annul energy.

1 Introduction

The main problem in the world is a consuming of high energy which becomes more necessary to do researches & invention to reduce this consuming of energy in the building . The amount of energies consumed in Iraq is equal to(26879) GW.hr which 60% is consumed in building for equipment's [1].

The growth in architecture side & increased the residential building increases of amount of energy wanted in residential building which caused a big problem as the supplied energy by electrical energy, this cause releasing co_2 gases from electrical power by used fossil fuel which will doing a universal warming ,so many several international agency was established to improve energy efficiency in building and give the buildings substantial particularity like LEED agency in U.S and estidama in Abu Dhabi[2] .

The amount of solar heat received by the surface of a house can be minimized for any period of the year thought treatment of the[3] :-

(1)shape and orientation of the building plan with respect to the sun .

(2) height of the building exposed to the sun.

(3)shape and pitch of the roof, with continuous shading controls at the façades.

The building shape effect on stream lines pass horizontally around the building and the wind causes variable surface pressure on buildings that changes the intake and exhaust system flow rates, natural ventilation, infiltration as shown in figure(1)[4].

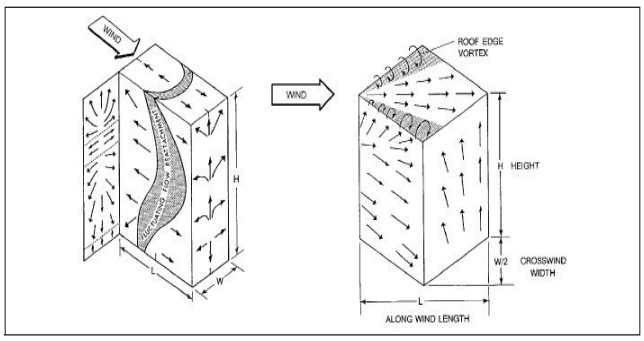
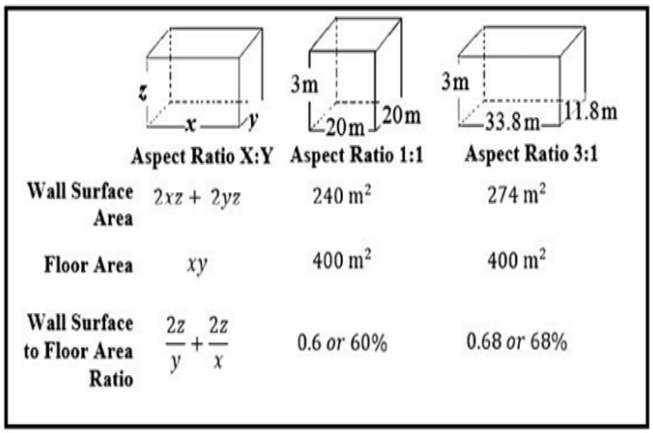


Fig 1, show the air flow pattern through building

The building's aspect ratio determines the amount of surfaces area from which heat will be transferred to and from the environment .Minimizing the amount of surface area reduces energy transfer .An analysis of geometry revelation that changing the aspect ratio results in different surface area for an equivalent floor area as shown figure(2).

The effect of aspect ratio on the exterior surface area will have a large impact on smaller building footprints[5].



	Aspect Ratio X:Y	Aspect Ratio 1:1	Aspect Ratio 3:1
Wall Surface Area	$2xz + 2yz$	240 m^2	274 m^2
Floor Area	xy	400 m^2	400 m^2
Wall Surface to Floor Area Ratio	$\frac{2z}{y} + \frac{2z}{x}$	0.6 *or* 60%	0.68 *or* 68%

Fig 2,The relations between wall surface area and aspect ratio

2-Methodology

2.1 Selection of model to prepare the dimension

The model was selected a residential house in Kirkuk city with 200 m^2 Floor area& a net building area of 135.2m^2 irregular shape with equivalent dimension of (13*10.4)m^2, the figure (3) show the envelope of the building.

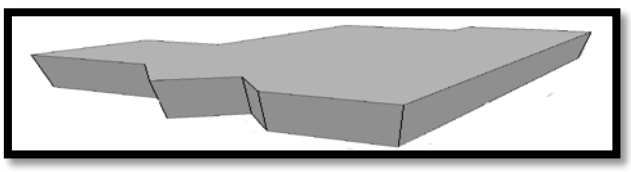


Fig 3,Shape of building envelope

Then design a program by using Visual basic 6 to insert the equivalent dimension to calculate original aspect ratio &then calculated the average width and length of other four aspect ratio's

(1:1,1:1.25,1:1.5,1:2) proposed of the building for the same building area using the following relations[2]:-

$$AR=\frac{average\ \ width}{average\ \ length}=\frac{Wav}{L\ av}\text{……..(1)}$$

$$Area=Wav*Lav\text{……(2)}$$

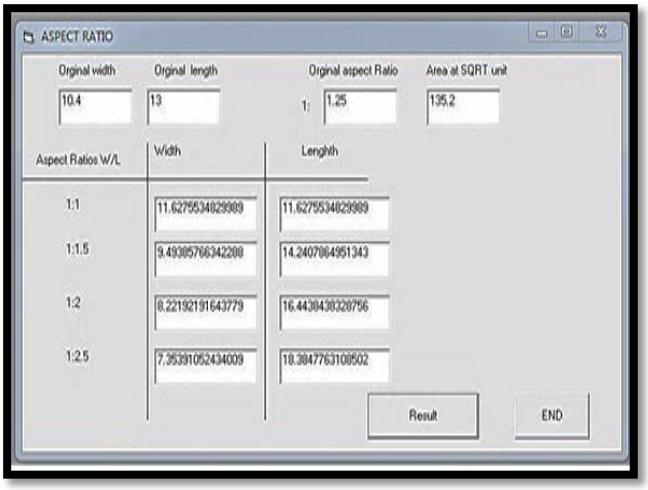
From equation 1&2, we obtain:-

$$Wav=\sqrt{\frac{area}{AR}}\text{…….(3)}$$

$$Lav=AR*Wav\text{…….(4)}$$

Where:- AR=aspect ratio

The figure(4) shows input and output of the program



Fig(4):-The window of helped program and the aspect ratio's value

2.2 preparation the weather data

2.2.1Hourly weather data

We insert hourly Kirkuk weather data(dry bulb temperature, relative humidity, wind speed, direct solar radiation, diffused solar radiation) in the converter weather data, which show in figure(5) the result as a picture diagram through the year.

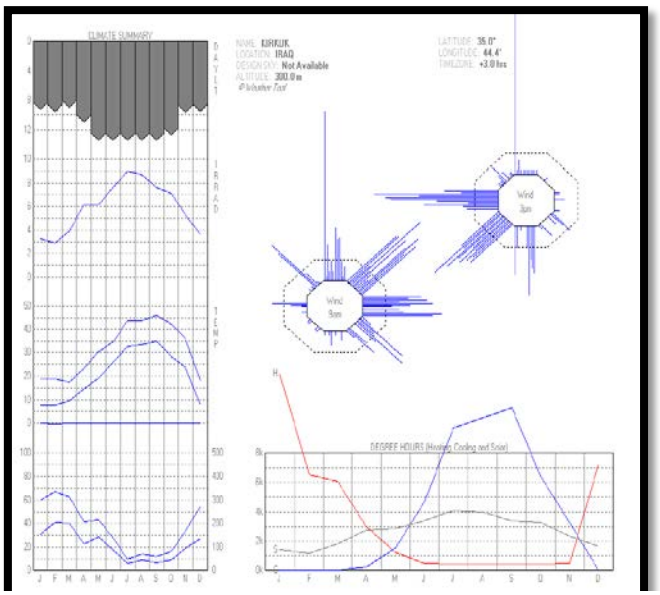


Fig 5,The result of Kirkuk weather(Dry bulb temperature, Wind speed, Sky light)

2.2.2 Sunpositions

Adjust the direction of solar radiation of sun for Kirkuk city by insert y axis which represented the latitude angles at degree to adjust the yearly solar position of sun as shown in figure(6) ,and saving it's in Ecotect building simulation programs.

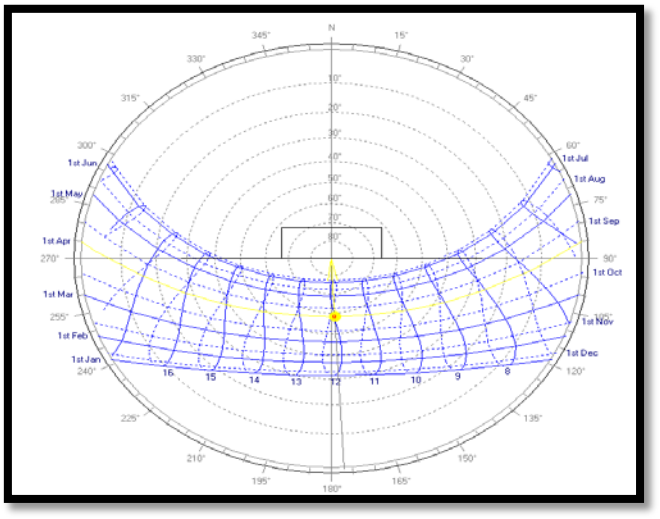


Fig 6,Show the path of the sun

2.2.3 Model drawing

Draw the building model in Ecotect data space [7] as shown in figure(7)

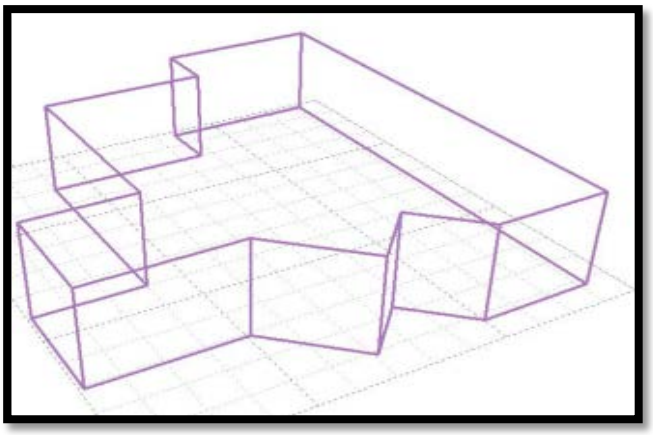


Fig 7,Show the building shape drawn in program

3 Building simulation program:-

The dimension of each part in all walls of irregular shape of the building as shown in figure (8),is translated to the new equivalent dimensions as shown in figure(9) which represent four aspect ratio of the building (1:1,1:1.25 ,1:1.5,1:2).

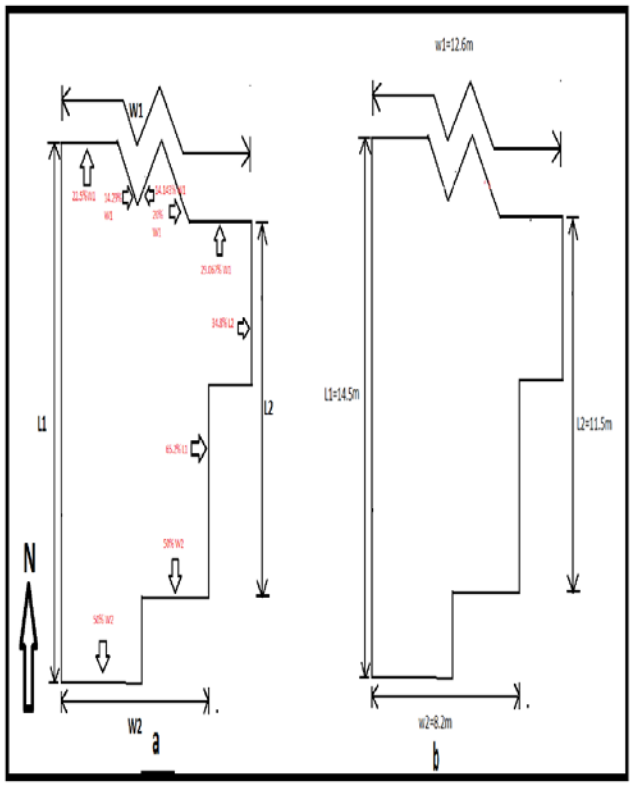


Fig 8,a-the original dimensions of building. b-the rate of each wall according to total dimensions.

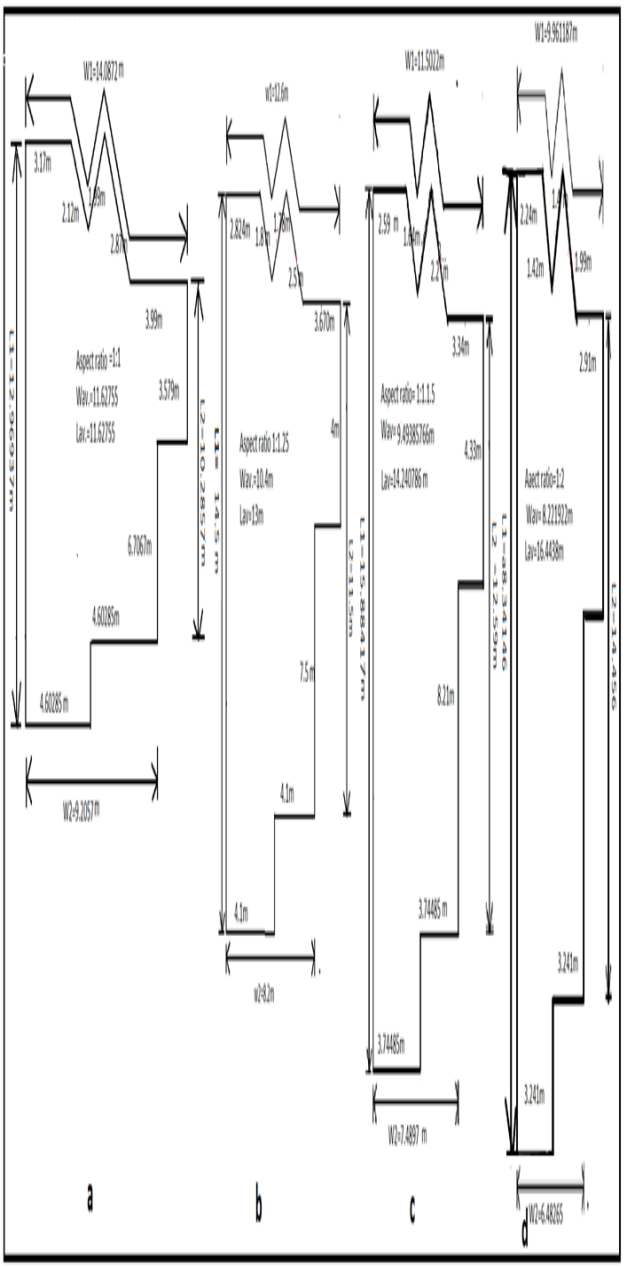


Fig 9,The dimensions of four cases a(1:1.), b(1:1. 25),c(1:1.5),d(1:2)

Then taking the building at each aspect ratio and oriented it to eight direction (north, north east, east, south east, south ,south west, west, north west) as shown in figure(10) and then simulated it by Ecotect program with selected the conditions of comfort zoning for each aspect ratio with all orientations of building using set point of cooling and heating system between(22-24)^{o}C and the amount of clothes (0.6clo)[8] with the relative humidity of 50% and calculated the heating and cooling load for each

month and the peak load of design cooling and heating load further to the annual load without effect of door and window of the building.

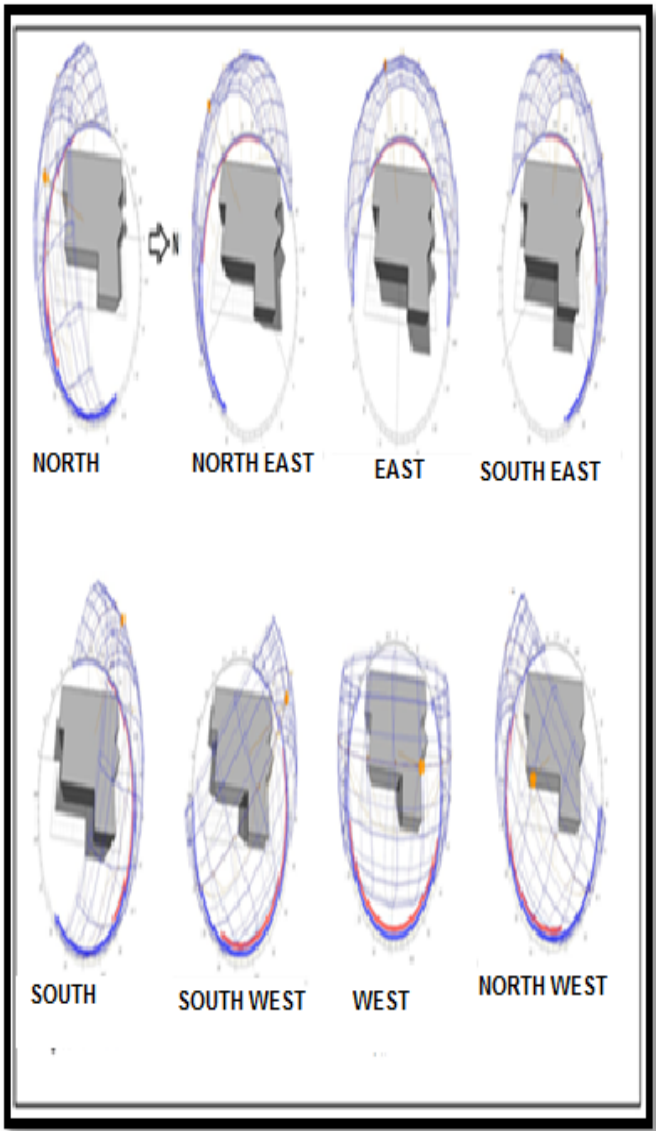


Fig 10,Building orientations

4.Results and discussion

After building simulation ,the results shows the values of four annual load which represent the sum of monthly cooling and heating load for each of four aspect ratio (1:1,1:1.25:1:1.5:1:2) in addition to the values of peak load of design cooling and heating for all eight orientation as shown in tables (1,2,3,4).

Orientation	Peak cooling load W	Peak heating load W	Annual load MWhr
North	11398	8144	33.681971
North East	11365	8144	33.662343
East	11355	8144	33.585517
South East	11370	8144	33.752864
South	11388	8144	33.688854
South West	11344	8144	33.657270
West	11301	8105	33.445911
North West	11620	8133	33.930457

Table 1,Shown the annual load ,peak cooling and heating load for all orientations of aspect ratio (1:1).

Orientation	Peak cooling load W	Peak heating load W	Annual load MWhr
North	12152	8602	35.464490
North East	12154	8602	35.379472
East	12123	8602	35.242020
South East	12062	8602	35.465893
South	12149	8602	35.472317
South West	12193	8602	35.401226
West	12168	8602	35.263723
North West	12104	8602	35.489285

Table 2, Shown the annual load ,peak cooling and heating load for all orientations of aspect ratio (1:1.25).

Orientation	Peak designed cooling load W	Peak designed heating load W	Annual load MWhr
North	12315	8746	36.071982
North East	12361	8746	35.959354
East	12336	8746	35.768538
South East	12280	8746	36.029324
South	12315	8746	36.074616
South West	12388	8746	35.976525
West	12362	8746	35.782431
North West	12311	8746	36.038095

Table 3, Shown the annual load ,peak cooling and heating load for all orientations of aspect ratio (1:1.5).

Orientation	Peak cooling load W	Peak heating load W	Annual load MWhr
North	12777	8975	37.176683
North East	12792	8975	37.014999
East	12745	8975	36.733903
South East	12719	8975	37.069547
South	12719	8975	37.069547
South West	12733	8975	37.008143
West	12370	8975	36.732218
North West	12705	8975	37.063290

Table 4, Shown the annual load ,peak cooling and heating load for all orientations of aspect ratio (1:2).

From the tables, we seen minimum annual load for each aspect ratio at one orientation & that results shows in monthly load diagram which resultant from simulation as shown in figure(11,12,13,14).

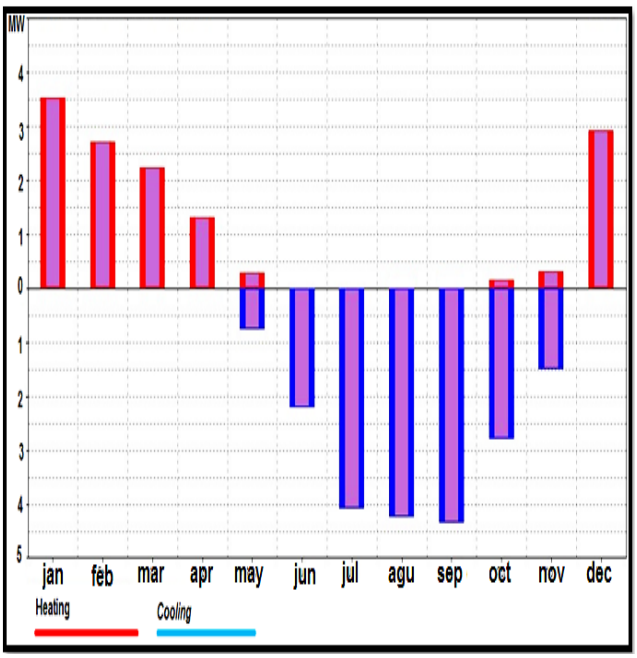


Fig 11,Shown monthly load graph for west oriented (270°) which represent minimum annual load for aspect ratio(1:1)

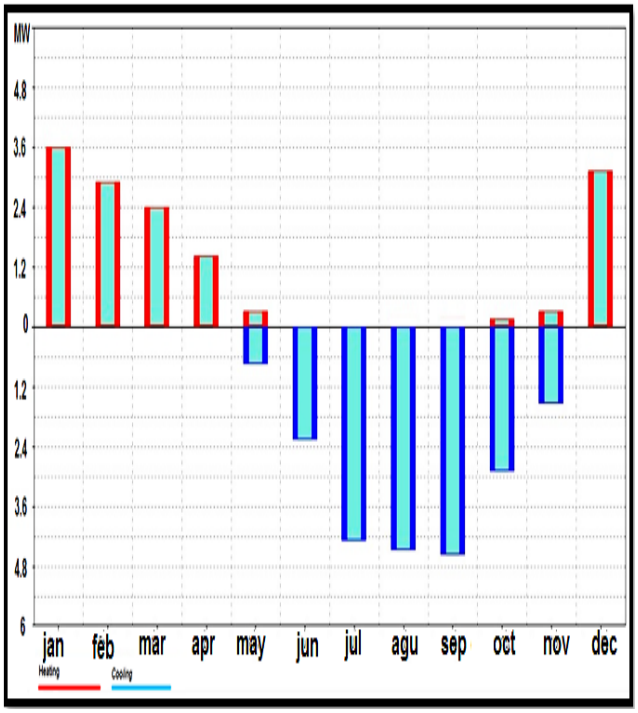


Fig 12,Shown monthly load graph for eat oriented (90°) which represent minimum annual load for aspect ratio(1:1.25)

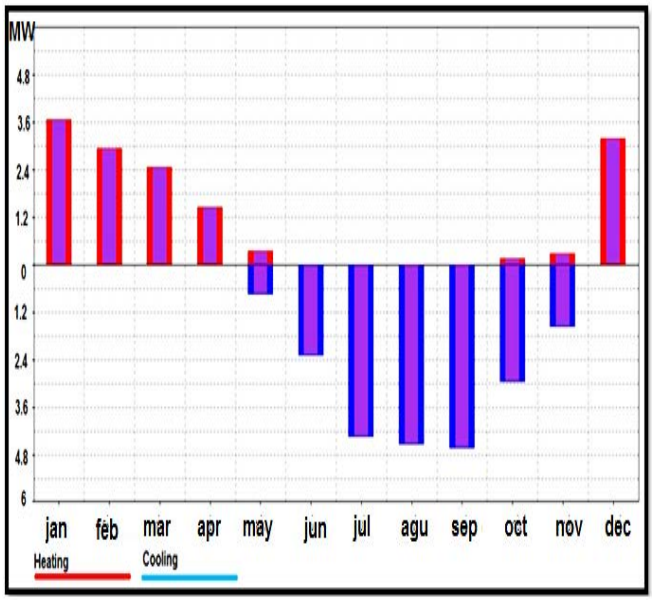


Fig 13,Shown monthly load graph for east oriented (90°) which represent minimum annual load for aspect ratio(1:1.5)

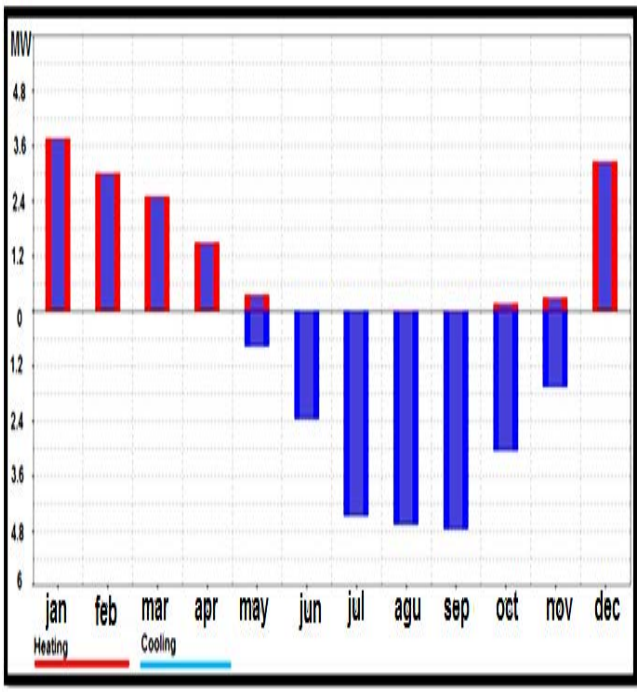


Fig 14,Shown monthly load graph for west oriented (270°) which represent minimum annual load for aspect ratio(1:2)

From the results shown in tables, the value of consumed annual load with eight orientation for all four aspect ratio shown in figure(15).

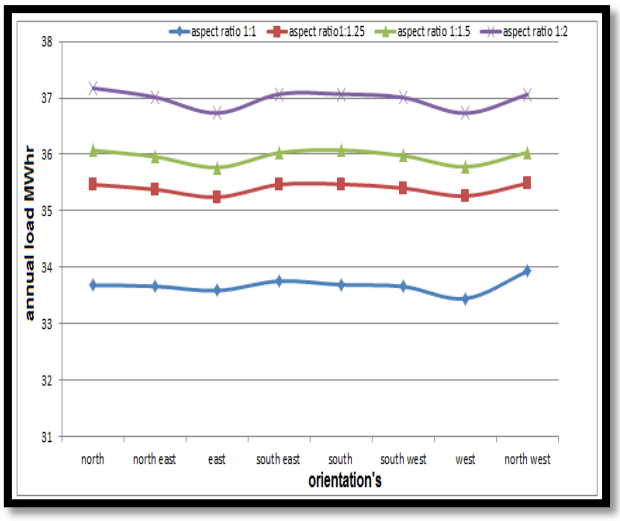


Fig 15, Values of consumed annual with orientated for each cases of aspect ratio's(1:1,1:1.25,1:1.5,1:2)

Also from result shown in tables, we obtained ratio of annual saving load with all eight orientation for each aspect ratio as shown in figure(16).

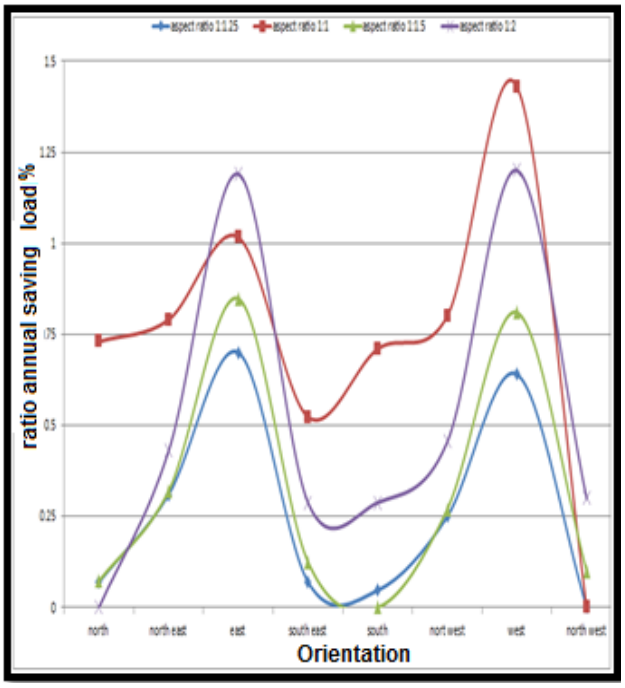


Fig 16,Ratio annual saving load with orientated for each aspect ratio's(1:1,1:1.25,1:1.5,1:2)

5.Conclusion

a. The best energy efficiency obtains when the shape of the building is square that is aspect ratio is (1:1) in west direction and this efficiency decreases as increases in aspect ratio as shown in Figure(15).

b. The best energy efficiency for the same aspect ratio is when oriented the building to west direction for aspect ratio(1:1,1:2) and to east direction for aspect ratio(1:1.25,1:1.5) as shown in figure(15)

c. The saving annual ratio for consume of energy is about 10% when the aspect ratio of building is(1:1) at west direction compared with peak annual load shown in fig(16) for aspect ratio (1:2) in north direction .

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