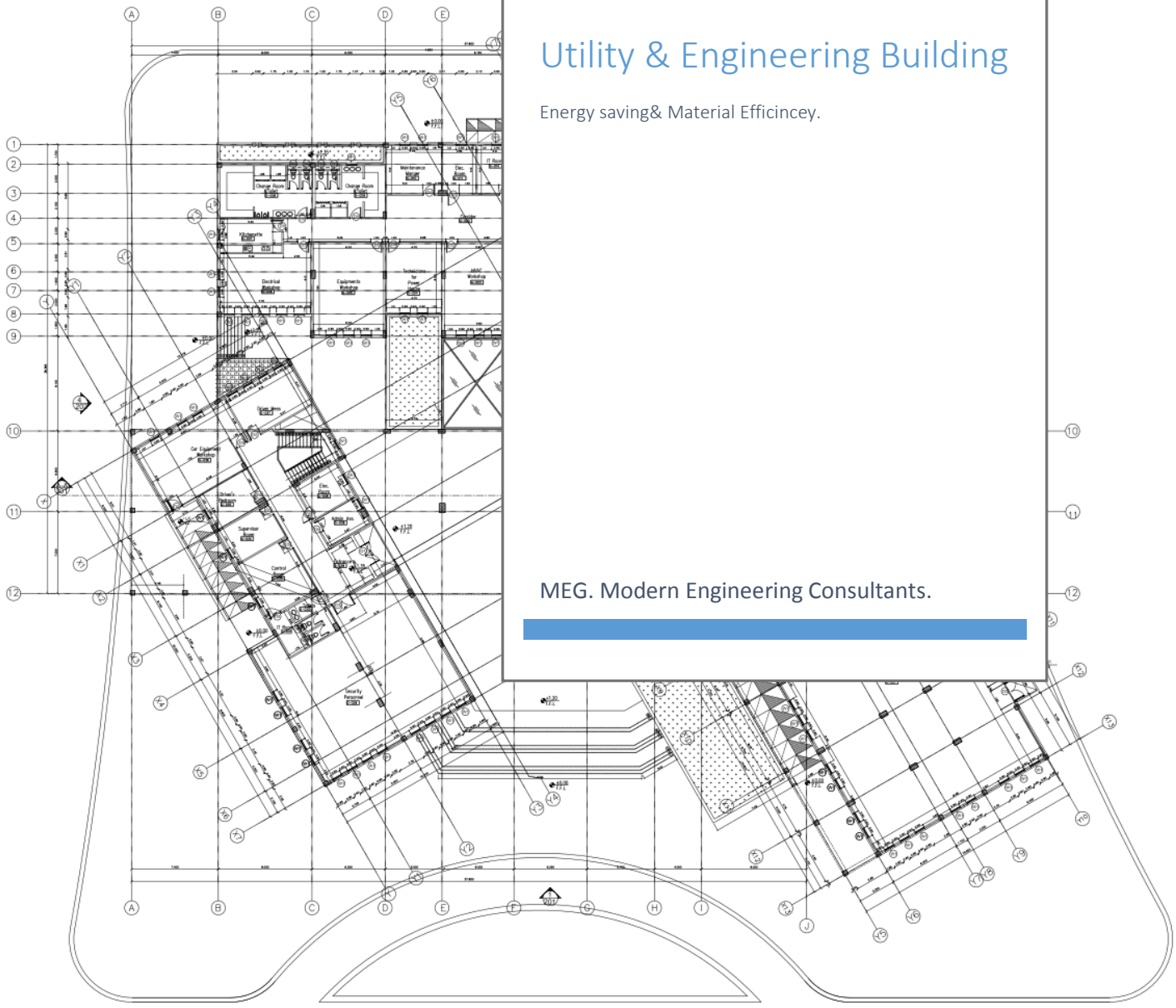
This report is prepared to compare between the AAC Aerated Autoclaved cement block and other cement\clay brick locally available in the local market.

Utility & Engineering Building

Energy saving& Material Efficincey.



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1. EXECUTIVE SUMMARY:

The main target of the report is to identify the thermal efficiency of using DELTA BLOCK material compared with other cement brick and clay brick material locally available in the market as well

Delta block can save up to 23% of the HVAC load alone if used as an alternative of the cement brick or clay brick that give saving of electricity 75015 Kwh\year and 2251 EGP\year from total electrical bill 9681 EGP\year.

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2. DEFINITIONS:

2.1. Passive gain breakdown (Wall thermal Gains & losses while heating and cooling which could be identified as level of material insulation):

The passive gains breakdown graph maps gains and losses that occur via the various heat transfer mechanisms that occur within a zone. These mechanisms include conduction, sol-air, direct solar, ventilation, internal and inter-zonal gains & losses.

2.2. Space load (heating and Cooling Loads):

Space load graph maps monthly total heating and cooling loads for each zone, calculating space load for the Utility and service building.

2.3. Resources Consumption (electrical process & non Process loads):

Calculating the consumption within the building model. In this case study simulating the electrical and natural gas uses only for operating the building.

2.4. Thermal Lag (Time Lag):

The Thermal Lag of a building material is the time taken for heat energy to pass from one side to the other, Thermal lag is always given in hours.

For a window this value becomes the Alternating Solar Gain and indicates the amount of short-wave incident solar radiation transmitted through the window and its effect on internal heat flows.

2.5. Decrement Factor, Decrement Delay:

- The term "**decrement delay"** refers to the time it takes for heat to pass through an element of a building (such as an external wall or roof). Typically this is taken to be the delay in hours between the peak temperature of the outer surface of the element on a summer day and the resulting peak temperature of the internal surface.

-The term '**decrement factor**' refers to the amount by which conditions are moderated by an element of a building. I.e. "in the case of the peak temperature on the outer surface of a building on a summer day, this would be the amount by which the peak is reduced by the time it reaches the inner surface". It is expressed as the ratio between the internal surfaces cyclic temperature variation compared to the external surface.

2.6. U-Value:

Is basically the air-to-air transmittance of a building material due to the thermal conductance of its constituent materials and the convective and radiative effects of its surfaces and cavities, It is the reciprocal of total resistance to heat flow and its SI units are $W / m^2 °K$.

3. BUILDING DESCRIPTION:

Utility and service building at Zewel science city located at the west part of Metropolis Cairo at point:

Latitude: 30.13° North.

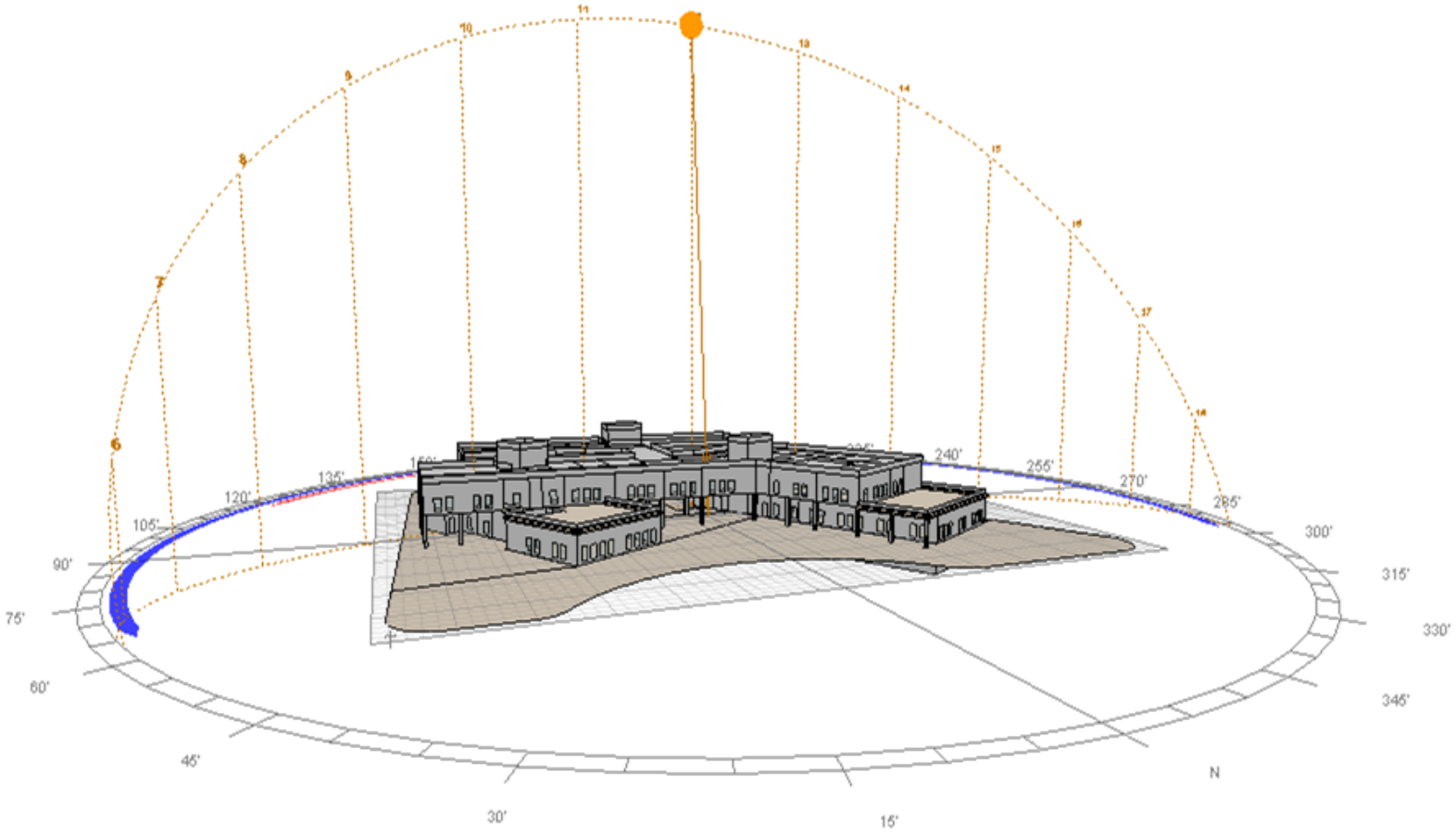
Longitude: 31.4 ° East.

With data source: ETMY Data Source.

Station Number: 623660 WMO.

Elevation: 74 m over sea level.

The main elevation and entrance is facing almost north direction as shown in the project construction document.



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4. MATERIAL CHARACTERIZATION:

4.1. Variable used to analyze DELTA BOLOCK performance:

4.1.1. ISO 6946. Calculation setting used by thermal calculator:

Item of calculation	Term	Remarks
Period	24 Hr. Test	Default - 24 hours
Internal surface resistant	0.13 m²K\W	Default from ISO 6946- 0.13 m²K/W
External surface resistant	0.04 m²K\W	Default from ISO 6946- 0.13 m²K/W

4.2. Material Selection:

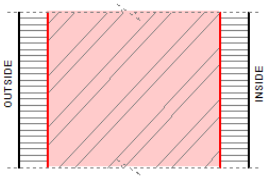
1. **120 mm thick cement brick with plaster.**

- Wall material properties:

Layer Name	Thickness (mm)	Density (kg\m³)	Specific heat capacity (J/kg/K)	Thermal conductivity (W/m/K)
stucco(Dense)	30	1300	840	0.57
Cement Brick 120 mm	120	2300	1000	1.87
Plaster (Dense)	20	1300	840	0.57

- Wall Thermal Properties:

Decrement factor [-]	Time lag [hours]
0.58	4hr , 45 min
Areal Heat Capacity [kJ/m2K]	Simplified U-value [W/m2K]
66	3.11



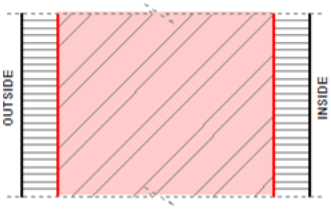
2. **250 mm thick cement brick with plaster.**

- Wall material properties:

Layer Name	Thickness (mm)	Density (kg\m³)	Specific heat capacity (J/kg/K)	Thermal conductivity (W/m/K)
stucco(Dense)	30	1300	840	0.57
Cement Brick 250 mm	250	2300	1000	1.75
Plaster (Dense)	20	1300	840	0.57

- Wall Thermal Properties:

Decrement factor [-]	Time lag [hours]
0.28	8hr , 15 min
Areal Heat Capacity [kJ/m2K]	Simplified U-value [W/m2K]
71	2.50



3. **120 mm thick clay brick with plaster.**

Layer Name	Thickness (mm)	Density (kg\m³)	Specific heat capacity (J/kg/K)	Thermal conductivity (W/m/K)
stucco(Dense)	30	1300	840	0.57
Clay Brick 120 mm	120	950	732.2	0.314
Plaster (Dense)	20	1300	840	0.57

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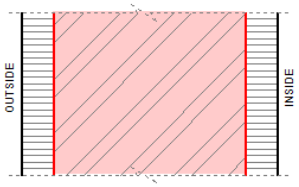
- Wall Thermal Properties:

Decrement factor [-]	Time lag [hours]
0.79	4hr , 09 min
Areal Heat Capacity [kJ/m2K]	Simplified U-value [W/m2K]
49	1.56

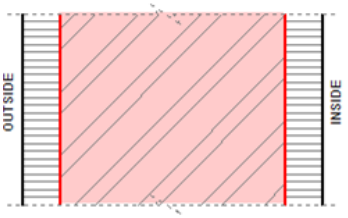


4. **250 mm thick clay brick with plaster.**

Layer Name	Thickness (mm)	Density (kg\m³)	Specific heat capacity (J/kg/K)	Thermal conductivity (W/m/K)
stucco(Dense)	30	1300	840	0.57
Clay Brick 250 mm	250	950	732.2	0.314
Plaster (Dense)	20	1300	840	0.57

- Wall Thermal Properties:

Decrement factor [-]	Time lag [hours]
0.41	8hr , 38 min
Areal Heat Capacity [kJ/m2K]	Simplified U-value [W/m2K]
53	0.95



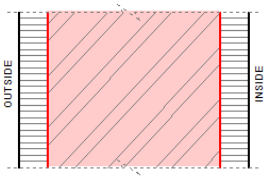
5. **120 mm thick Delta Block with plaster and stucco :**

- Wall material properties:

Layer Name	Thickness (mm)	Density (kg\m³)	Specific heat capacity (J/kg/K)	Thermal conductivity (W/m/K)
stucco(Dense)	30	1300	840	0.57
Cement Brick 120 mm	120	450	1000	0.132
Plaster (Dense)	20	1300	840	0.57

- Wall Thermal Properties:

Decrement factor [-]	Time lag [hours]
0.77	4 hr, 55 min
Areal Heat Capacity [kJ/m2K]	Simplified U-value [W/m2K]
45	0.84



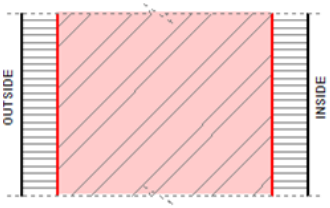
6. **250 mm thick Delta Block with plaster :**

- Wall material properties:

Layer Name	Thickness (mm)	Density (kg\m³)	Specific heat capacity (J/kg/K)	Thermal conductivity (W/m/K)
stucco(Dense)	30	1300	840	0.57
Cement Brick 250 mm	250	450	1000	0.132
Plaster (Dense)	20	1300	840	0.57

- Wall Thermal Properties:

Decrement factor [-]	Time lag [hours]
0.34	10 hr 28 min
Areal Heat Capacity [kJ/m2K]	Simplified U-value [W/m2K]
43	0.46



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5. ANALYSIS:

5.1. SPACE LOAD:

Space load graph maps monthly total heating and cooling loads for each zone, calculating space load for typical floor flat 190 m² net area.

5.1.1. CONSTANT LOAD FROM THE Lighting and electrical appliance:

RESOURCE USAGE - Daily Energy Use					
	lighting	Appliance	GAS	TOTAL	TOTAL
MONTH	(Wh)	(Wh)	(Wh)	(Wh)	(KWh)
------	----------	----------	-----	----------	----------
Jan	22706880	22706880	49104	45462864	45462.864
Feb	20509440	20509440	44352	41063232	41063.232
Mar	22706880	22706880	49104	45462864	45462.864
Apr	21974400	21974400	47520	43996320	43996.32
May	22706880	22706880	49104	45462864	45462.864
Jun	21974400	21974400	47520	43996320	43996.32
Jul	22706880	22706880	49104	45462864	45462.864
Aug	22706880	22706880	49104	45462864	45462.864
Sep	21974400	21974400	47520	43996320	43996.32
Oct	22706880	22706880	49104	45462864	45462.864
Nov	21974400	21974400	47520	43996320	43996.32
Dec	22706880	22706880	49104	45462864	45462.864
------	----------	----------	-----	----------	----------
TOTAL (Wh).	267355200	267355200	578160	535288560	535288.56
TOTAL (KWh).	267355.2	267355.2	578.16	535288.56	535288.56
COST (EGP).	8020.656	8020.656	17.3448	16058.6568	16058.6568

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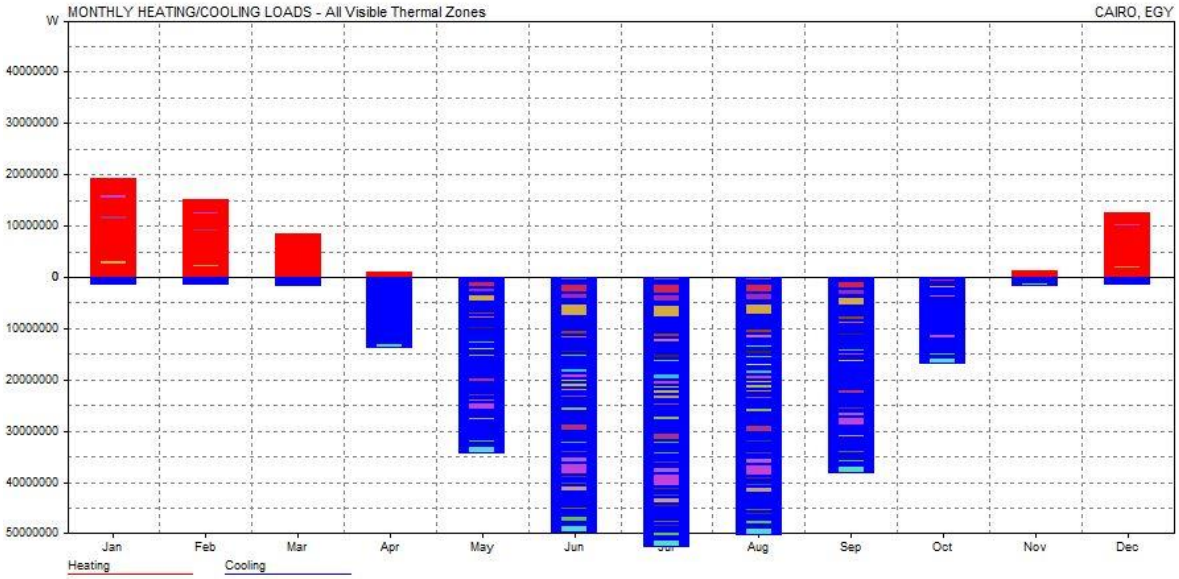
5.1.2. CEMENT BRICK 120 mm THICK:

MONTHLY HEATING/COOLING LOADS				
CEMENT BRICK 120 mm THICK WALL				
Max Heating: 81802 W at 08:00 on 22nd February				
Max Cooling: 393038 W at 15:00 on 7th June				
	HEATING	COOLING	TOTAL	TOTAL
MONTH	(Wh)	(Wh)	(Wh)	(Wh)
----------	---------	----------	----------	----------
Jan	19299384	0	20915960	20915.96
Feb	15214662	0	16671138	16671.138
Mar	8449165	0	10259732	10259.732
Apr	1084198	13857974	14942172	14942.172
May	0	34374312	34381124	34381.124
Jun	0	49873764	49884356	49884.356
Jul	0	52814744	52826936	52826.936
Aug	0	50430956	50442004	50442.004
Sep	0	38217256	38223108	38223.108
Oct	0	16946078	16947042	16947.042
Nov	1271193	0	3183548	3183.548
Dec	12532828	0	14023493	14023.493
----------	---------	----------	----------	----------
TOTAL	57851430	256515084	322700613	322700.613
COST (EGP)	1735.5429	7695.4525	9681.0184	9681.01839
----------	---------	----------	----------	----------
PER M²	6126	28017	34143	34143
Floor Area:	7193.556 m2			



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5.1.3. CEMENT BRICK 250 mm THICK:

MONTHLY HEATING/COOLING LOADS				
CEMENT BRICK 250 mm THICK WALL				
Max Heating: 51134 W at 08:00 on 22nd February				
Max Cooling: 342213 W at 15:00 on 7th June				
	HEATING	COOLING	TOTAL	TOTAL
MONTH	(Wh)	(Wh)	(Wh)	(KWh)
----------	---------	----------	----------	----------
Jan	9931744	0	9931744	9931.744
Feb	7732053	0	7732053	7732.053
Mar	4003915	0	4003915	4003.915
Apr	0	13876179	13876179	13876.179
May	0	31372476	31372476	31372.476
Jun	0	43038560	43038560	43038.56
Jul	0	45921244	45921244	45921.244
Aug	0	44057416	44057416	44057.416
Sep	0	34561760	34561760	34561.76
Oct	0	17091136	17091136	17091.136
Nov	0	0	0	0
Dec	6148576	0	6148576	6148.576
----------	---------	----------	----------	----------
TOTAL	27816288	229918771	257735059	257735.059
COST (EGP)	834.4886	6897.5631	7732.0518	7732.05177
----------	---------	----------	----------	----------
PER M²	3054	25980	29034	29035
Floor Area:	7193.556 m2			

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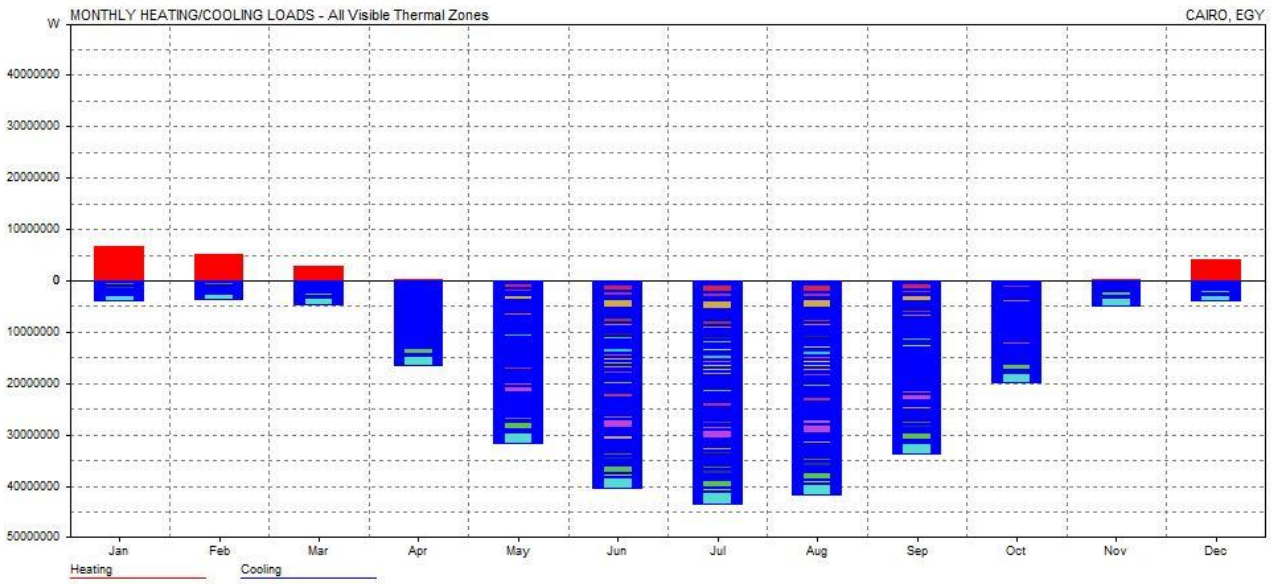
5.1.4. CLAY BRICK 120 mm THICK:

MONTHLY HEATING/COOLING LOADS				
Max Heating: 51183 W at 17:00 on 27th February				
Max Cooling: 329642 W at 15:00 on 7th June				
	HEATING	COOLING	TOTAL	TOTAL
MONTH	(Wh)	(Wh)	(Wh)	(KWh)
----------	---------	----------	----------	----------
Jan	16490806	0	16490806	16490.81
Feb	13005165	0	13005165	13005.17
Mar	7402399	0	7402399	7402.399
Apr	0	15910257	15910257	15910.26
May	0	35223860	35223860	35223.86
Jun	0	48459148	48459148	48459.15
Jul	0	51447592	51447592	51447.59
Aug	0	49276176	49276176	49276.18
Sep	0	38214708	38214708	38214.71
Oct	0	19459676	19459676	19459.68
Nov	1113022	0	1113022	1113.022
Dec	10848304	0	8302072	8302.072
----------	---------	----------	----------	----------
TOTAL	48859696	257991417	304304881	304304.9
COST (EGP)	1465.791	7739.7425	9129.1464	9129.146
----------	---------	----------	----------	----------
PER M²	2071	26519	28590	28590
Floor Area:	7193.556 m2			



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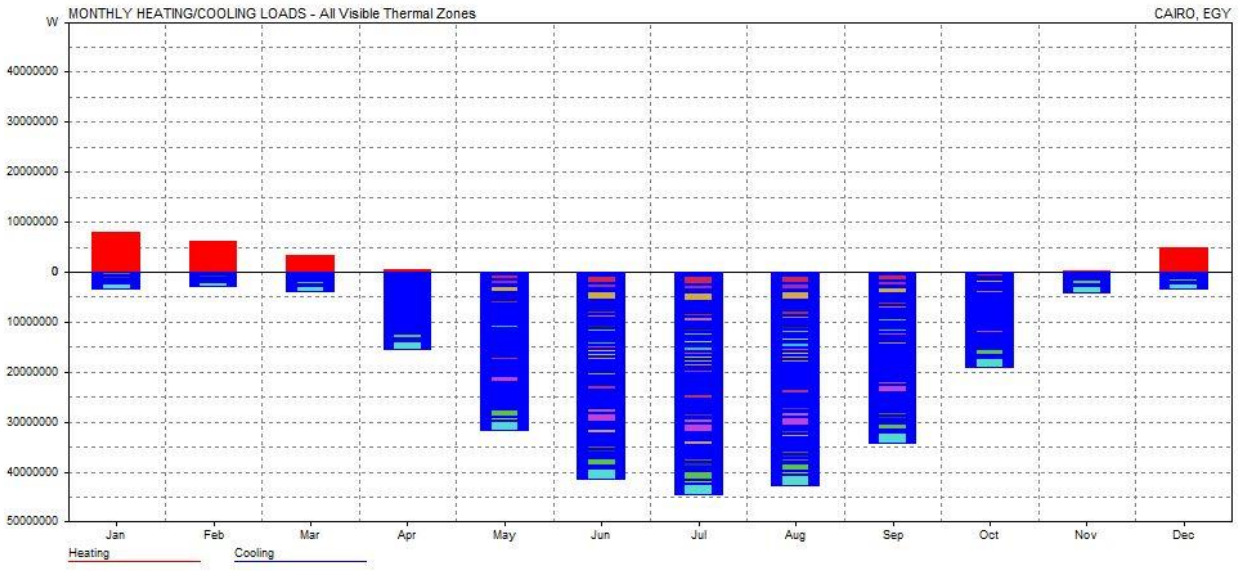
5.1.5. CLAY BRICK 250 mm THICK:

MONTHLY HEATING/COOLING LOADS				
Max Heating: 49224 W at 17:00 on 27th February				
Max Cooling: 336789 W at 15:00 on 7th June				
	HEATING	COOLING	TOTAL	TOTAL
MONTH	(Wh)	(Wh)	(Wh)	(KWh)
----------	---------	----------	----------	----------
Jan	8018174	0	8018174	8018.174
Feb	6218050	0	6218050	6218.05
Mar	3231724	0	3231724	3231.724
Apr	0	15700071	15700071	15700.07
May	0	31900686	31900686	31900.69
Jun	0	41747228	41747228	41747.23
Jul	0	44685572	44685572	44685.57
Aug	0	42954144	42954144	42954.14
Sep	0	34340760	34340760	34340.76
Oct	0	19226868	19226868	19226.87
Nov	356948	0	356948	356.948
Dec	4907712	0	4907712	4907.712
----------	---------	----------	----------	----------
TOTAL	22732608	2.31E+08	2.53E+08	253287.9
COST (EGP)	681.9782	6916.66	7598.638	7598.638
----------	---------	----------	----------	----------
PER M²	2453	26392	28844	28845
Floor Area:	7193.556 m2			



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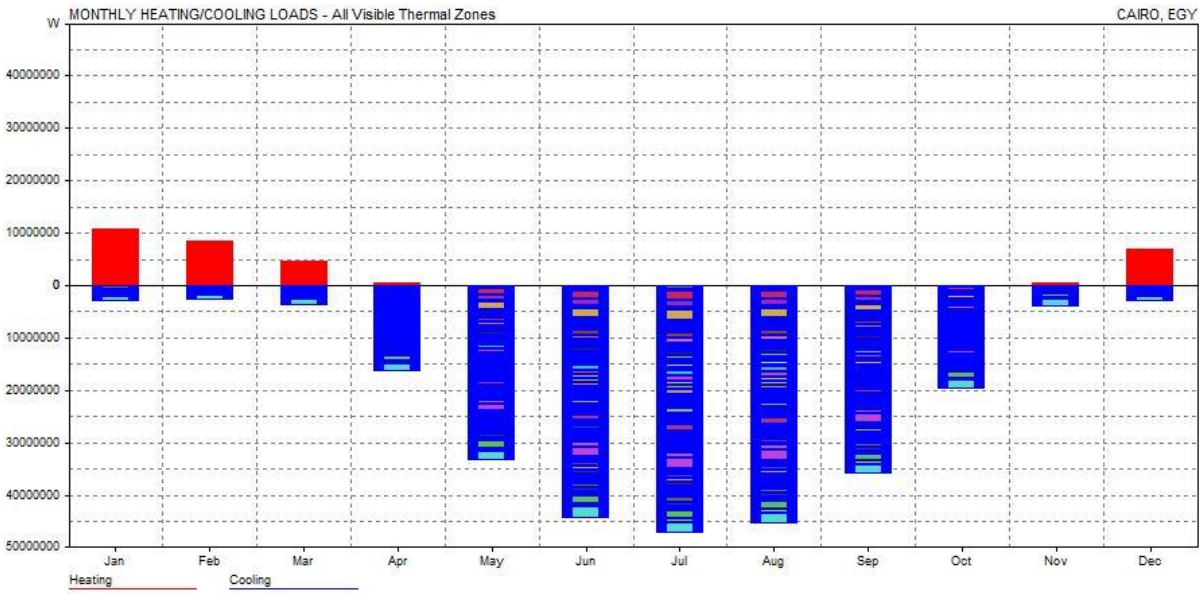
5.1.6. DELTA BLOCK 120 mm THICK:

MONTHLY HEATING/COOLING LOADS				
DELTA BLOCK 120 mm THICK				
Max Heating: 54382 W at 08:00 on 22nd February				
Max Cooling: 357689 W at 15:00 on 7th June				
	HEATING	COOLING	TOTAL	TOTAL
MONTH	(Wh)	(Wh)	(Wh)	(KWh)
----------	---------	----------	----------	----------
Jan	10313188	0	10313188	10313.188
Feb	7983748	0	7983748	7983.748
Mar	3928421	0	3928421	3928.421
Apr	0	15836258	15836258	15836.258
May	0	32724018	32724018	32724.018
Jun	0	43597732	43597732	43597.732
Jul	0	46440344	46440344	46440.344
Aug	0	44480608	44480608	44480.608
Sep	0	35203988	35203988	35203.988
Oct	0	19162894	19162894	19162.894
Nov	0	0	0	0
Dec	6090522	0	6090522	6090.522
----------	---------	----------	----------	----------
TOTAL	28315879	237445842	265761721	265761.721
COST (EGP)	849.47637	7123.37526	7972.85163	7972.85163
----------	---------	----------	----------	----------
PER M²	3407	27474	30881	30882
Floor Area:	7193.556 m2			



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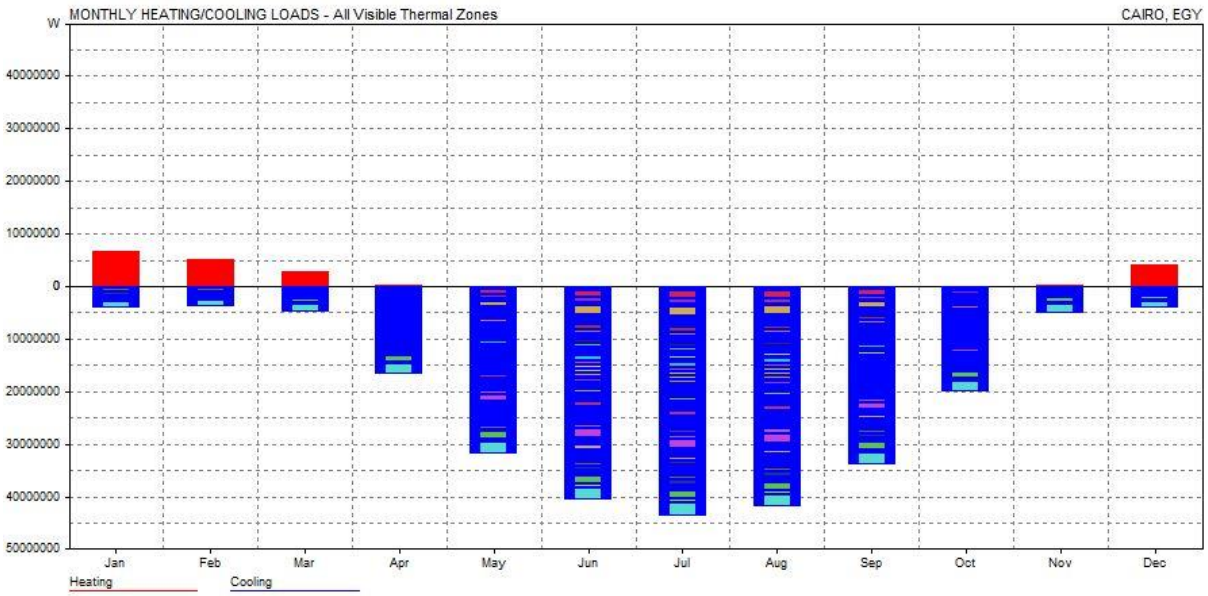
5.1.7. DELTA BLOCK 250 mm THICK:

MONTHLY HEATING/COOLING LOADS				
DELTA BLOCK 250 mm THICK WALL				
Max Heating: 56421 W at 17:00 on 27th February				
Max Cooling: 335949 W at 15:00 on 7th June				
	HEATING	COOLING	TOTAL	TOTAL
MONTH	(Wh)	(Wh)	(Wh)	(KWh)
----------	---------	----------	----------	----------
Jan	6804243	0	6804243	6804.243
Feb	5259918	0	5259918	5259.918
Mar	2706724	0	2706724	2706.724
Apr	0	16680882	16680882	16680.882
May	0	31906002	31906002	31906.002
Jun	0	40689444	40689444	40689.444
Jul	0	43623076	43623076	43623.076
Aug	0	41989088	41989088	41989.088
Sep	0	33814540	33814540	33814.54
Oct	0	20077518	20077518	20077.518
Nov	0	0	0	0
Dec	4134188	0	4134188	4134.188
----------	---------	----------	----------	----------
TOTAL	18905073	228780550	247685623	247685.62
COST (EGP)	567.15219	6863.4165	7430.5687	7430.5687
----------	---------	----------	----------	----------
PER M²	2489	26928	29417	29418
Floor Area:	7193.556 m2			



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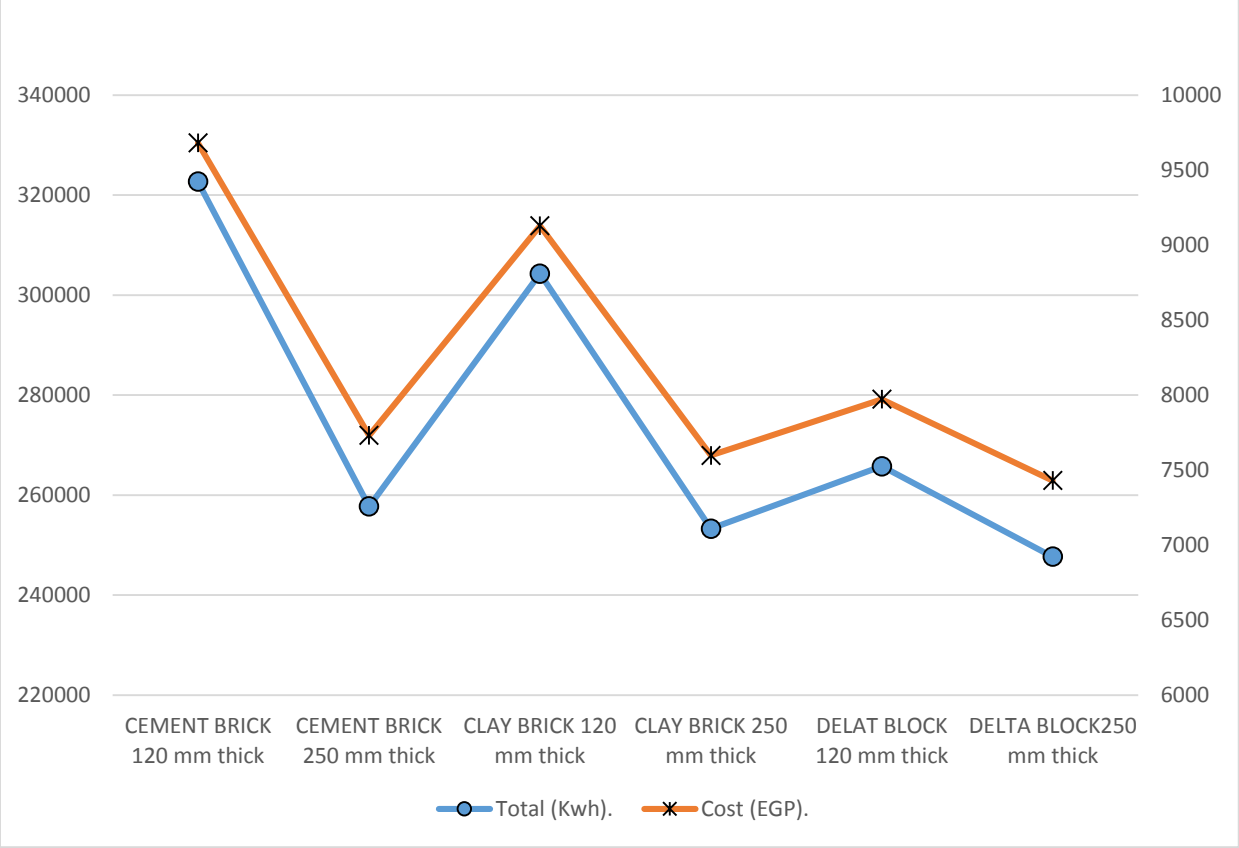
5.1.8. Comparison:

WALL TYPE / ITEM	Cement brick		Clay brick		Delta block	
	120 mm thick	250 mm thick	120 mm thick	250 mm thick	120 mm thick	250 mm thick
Total (Kwh).	322700.613	257735.059	304304.9	253287.9	265761.721	247685.62
Cost (EGP).	9681.01839	7732.05177	9129.146	7598.638	7972.85163	7430.5687



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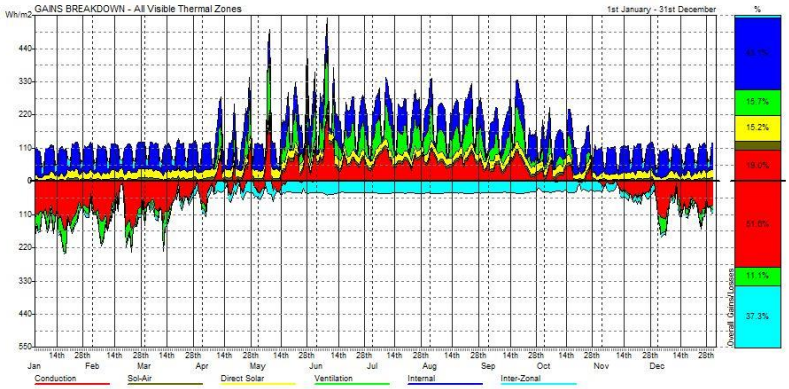
5.2. MATERIAL EFFICACY:

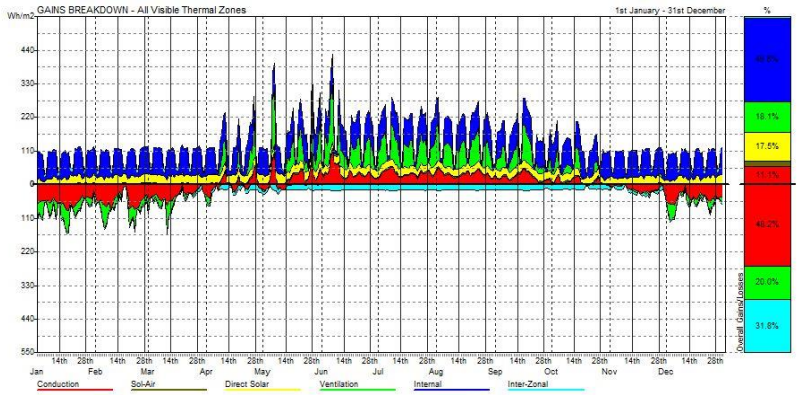
5.2.1. CEMENT BRICK 120 mm THICK:

GAINS BREAKDOWN - All Visible Thermal Zones		
FROM: 1st January to 31st December		
CATEGORY	LOSSES	GAINS
----------	-------	------
FABRIC	51.60%	19.00%
SOL-AIR	0.00%	5.50%
SOLAR	0.00%	15.20%
VENTILATION	11.10%	15.70%
INTERNAL	0.00%	43.10%
INTER-ZONAL	37.30%	1.60%



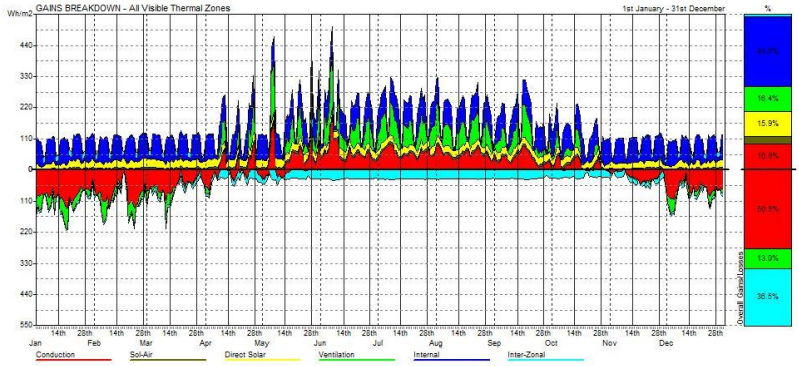
5.2.2. CEMENT BRICK 250 mm THICK:

GAINS BREAKDOWN - All Visible Thermal Zones		
FROM: 1st January to 31st December		
CATEGORY	LOSSES	GAINS
----------	-------	------
FABRIC	48.20%	11.10%
SOL-AIR	0.00%	2.80%
SOLAR	0.00%	17.50%
VENTILATION	20.00%	18.10%
INTERNAL	0.00%	49.60%
INTER-ZONAL	31.80%	0.80%



5.2.3. CLAY BRICK 120 mm THICK:

GAINS BREAKDOWN - All Visible Thermal Zones		
FROM: 1st January to 31st December		
CATEGORY	LOSSES	GAINS
----------	-------	------
FABRIC	50.50%	16.90%
SOL-AIR	0.00%	4.70%
SOLAR	0.00%	15.90%
VENTILATION	13.00%	16.40%
INTERNAL	0.00%	44.80%
INTER-ZONAL	36.50%	1.40%



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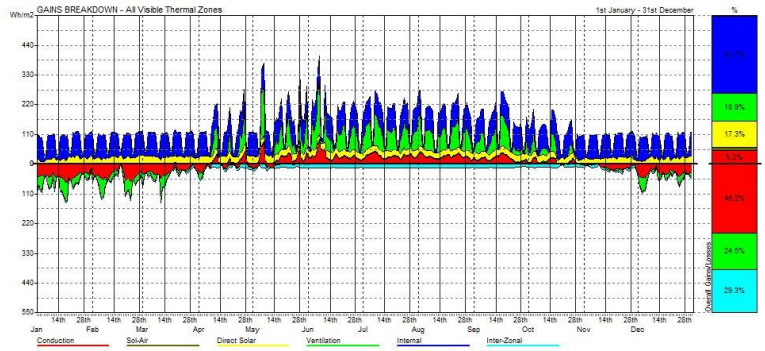
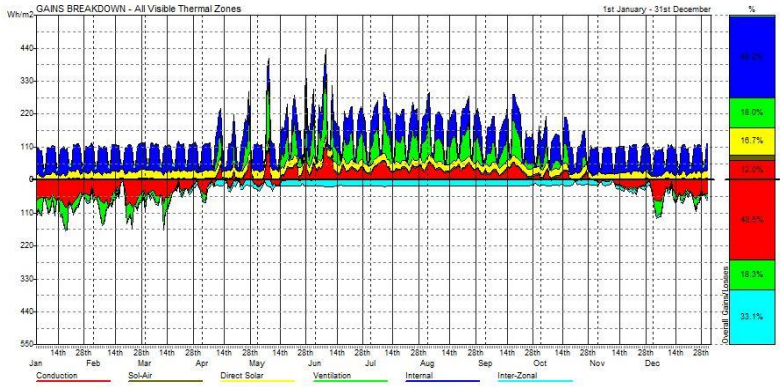
5.2.4. CLAY BRICK 250 mm THICK:

GAINS BREAKDOWN - All Visible Thermal Zones		
FROM: 1st January to 31st December		
CATEGORY	LOSSES	GAINS
----------	-------	------
FABRIC	46.20%	9.20%
SOL-AIR	0.00%	2.20%
SOLAR	0.00%	17.30%
VENTILATION	24.50%	18.90%
INTERNAL	0.00%	51.70%
INTER-ZONAL	29.30%	0.70%



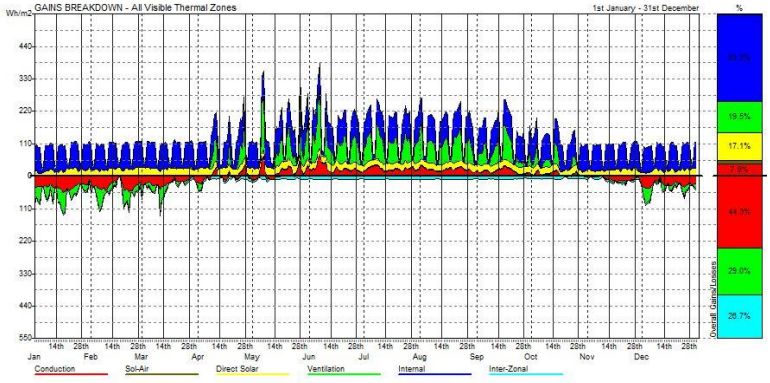
5.2.5. DELTA BLOCK 120 mm THICK:

GAINS BREAKDOWN - All Visible Thermal Zones		
FROM: 1st January to 31st December		
CATEGORY	LOSSES	GAINS
----------	-------	------
FABRIC	48.50%	12.00%
SOL-AIR	0.00%	3.10%
SOLAR	0.00%	16.70%
VENTILATION	18.30%	18.00%
INTERNAL	0.00%	49.20%
INTER-ZONAL	33.10%	1.00%



5.2.6. DELTA BLOCK 250 mm THICK:

GAINS BREAKDOWN - All Visible Thermal Zones		
FROM: 1st January to 31st December		
CATEGORY	LOSSES	GAINS
----------	-------	------
FABRIC	44.30%	7.90%
SOL-AIR	0.00%	1.80%
SOLAR	0.00%	17.10%
VENTILATION	29.00%	19.50%
INTERNAL	0.00%	53.30%
INTER-ZONAL	26.70%	0.50%



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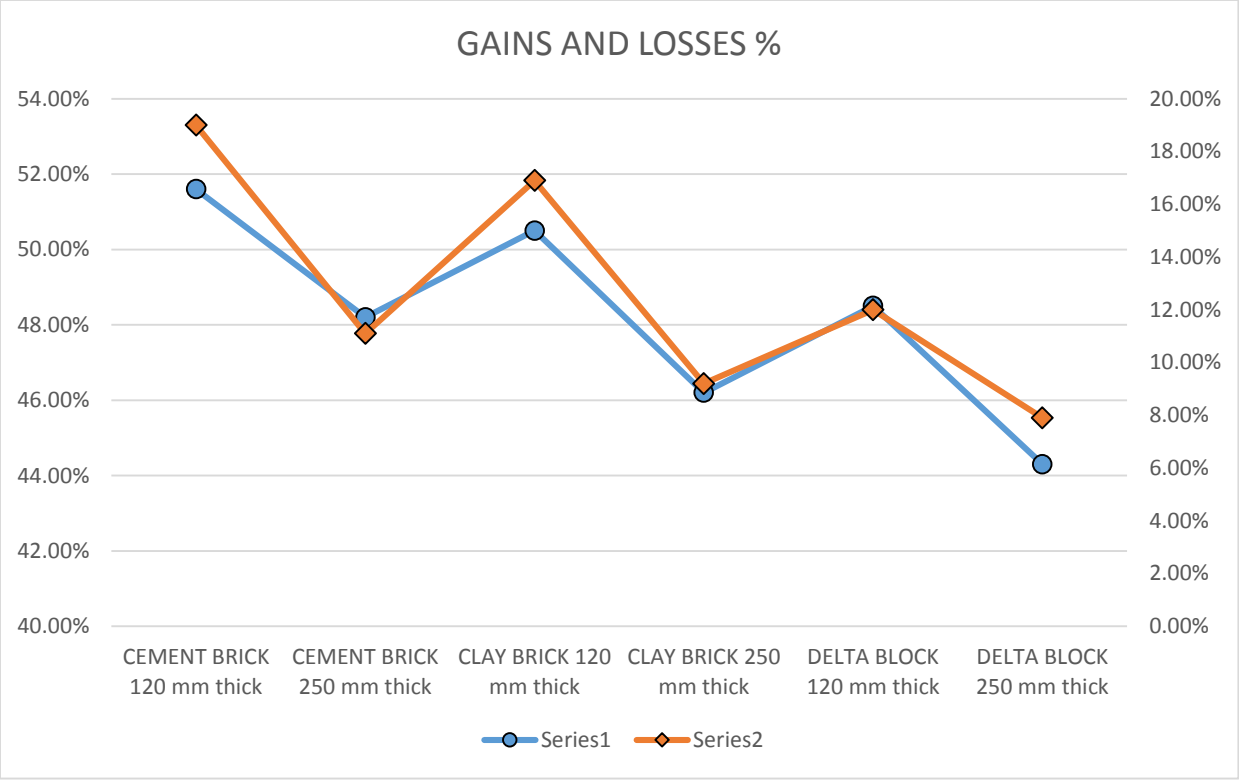
5.2.7. Comparison:

ITEM \ WALL TYPE	Cement brick		CLAY BRICK		Delta block	
	120 mm thick	250 mm thick	120 mm thick	250 mm thick	120 mm thick	250 mm thick
MATERILA LOSSES WHEN COOLING	51.60%	48.20%	50.50%	46.20%	48.50%	44.30%
MATERIAL GAINS WHEN HEATING	19.00%	11.10%	16.90%	9.20%	12.00%	7.90%



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6. STRUCTURE COMPARISON:

Study for Using Light Weight Bricks and Ordinary Bricks

6.1. Introduction:

This document describes the comparison procedure between using the light weight bricks and ordinary weight bricks in buildings and the effect to the building weight and hence to the columns and foundations quantities.

6.2. Case Study:

In this report, a building of certain properties will be used under some different factors for checking the effect of using light weight bricks in the building concrete columns and foundation quantities, the building properties are as follow:

1- The building area is 30.00m x 30.00m.
2- The building will be used as administration building, live loads=400Kg/m2.
3- The finishing of the building will be porcelain or ceramic, floor cover = 200 Kg/m2.
4- The building will be studied under one floor to 10 floors taking into consideration the earthquake effect as a percentage.
5- Soil bearing capacity will be assumed to be 10 t/m2
6- The comparison will be between using ordinary bricks of density weight 1800 Kg/m3 (gives 200Kg/m2) and the light weight bricks of 850 Kg/m3 (gives 95Kg/m2), the values are assumed as one distribution of walls.

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6.3. Calculation Process:

This section will use the following sketch in the comparison:

Item	Ordinary Bricks building	Light brick building
Slab weight (O.W.)	625	625
Live Loads (L.L.) (Kg/m2)	400	40
Floor Cover (F.C.) (Kg/m2)	200	200
Partitions (PART) (Kg/m2)	200	95
Total Weight (Kg/m2)	1425	1320

6.4. Subject:

Comparison Study for Using Light Weight Bricks and Ordinary Bricks For the seismic effect, an empirical method will be used in obtaining the static loads that 15% of the dead loads only of the floor will be added to the weight, these adding will be after the 4th floors.

The following tables and graphs show the followings:

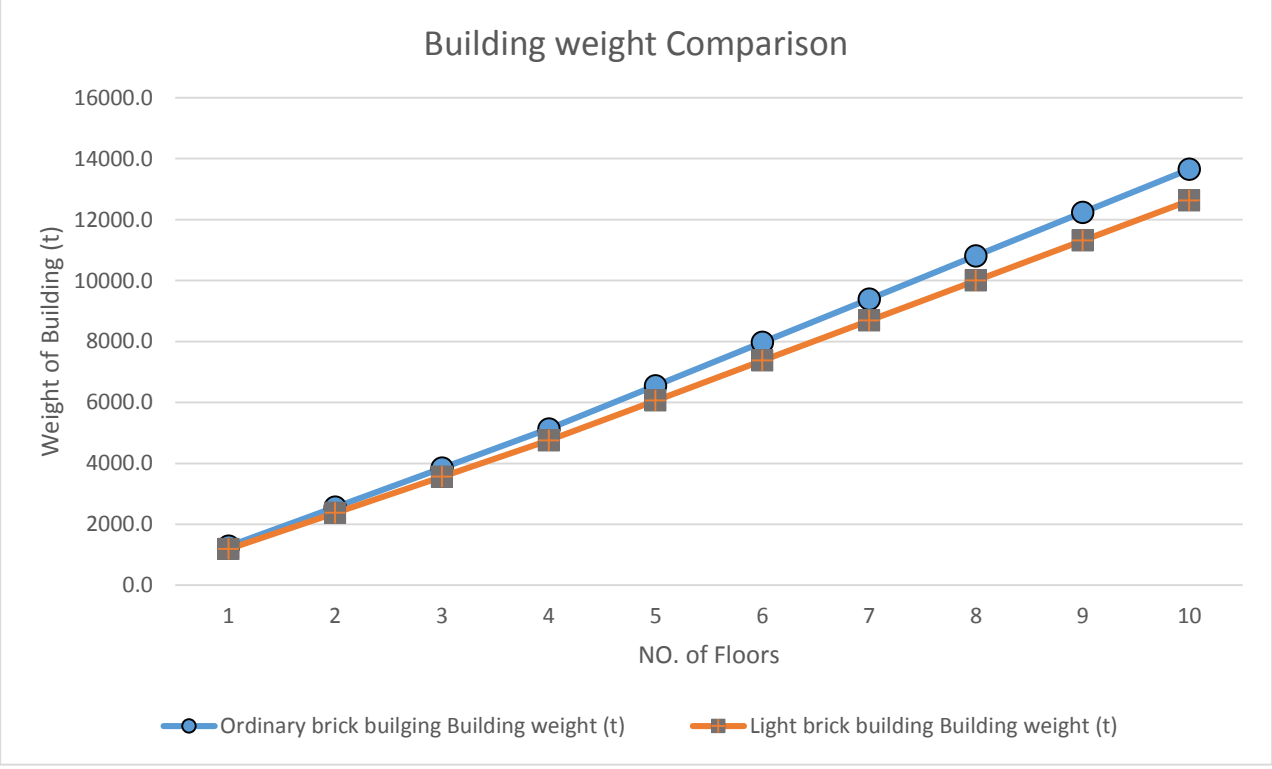
1- The following table shows the comparison and difference between the building loads and concrete saving due to using the light weight bricks

2- Also, the first graph shows the difference in the building weight.

3- Finally, the second graph shows the concrete volume saving due to using the light bricks.

Comparison Table for Concrete:

6.4.1. Comparison between Ordinary bricks and Light bricks:



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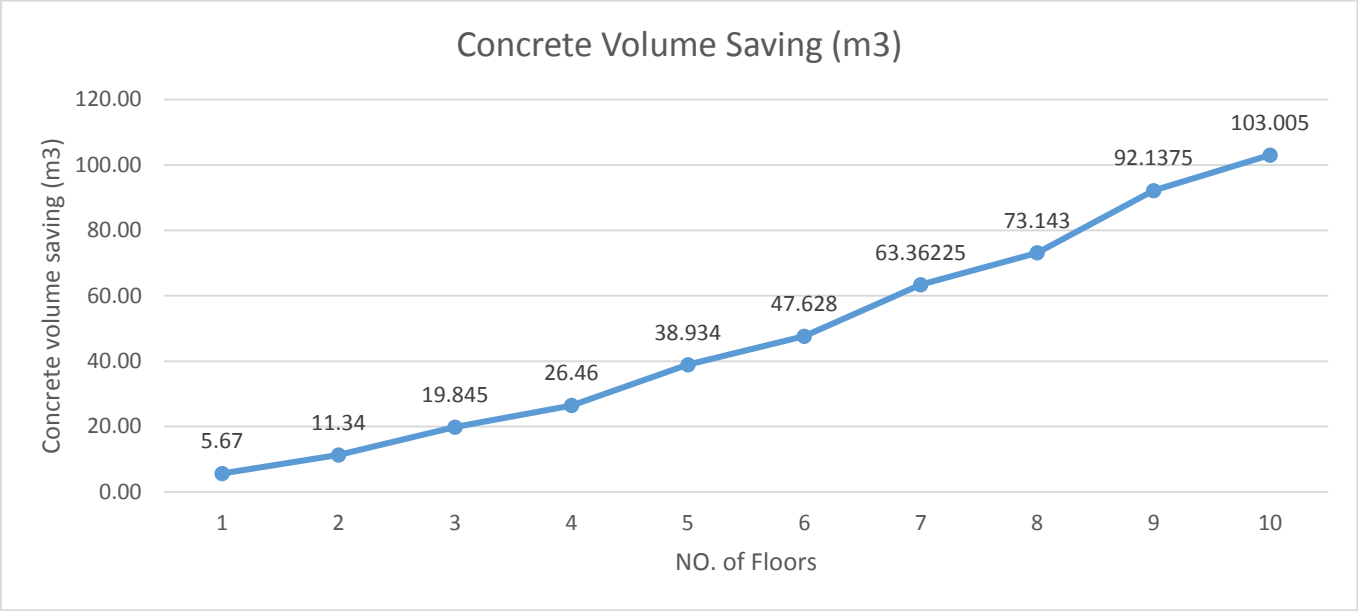
6.4.2. Graph for Footing Concrete Saving:



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