Calibration of "Design Builder program"

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Abstract: The research discussed the importance of calibration of environmental simulation programs, then an overview about Design Builder program. In addition to clarification the methodology that will study with, by doing a practical study case to the building of "El- Wasta prep school for girls" in "El-Wasta Beni Suef " with detailed description and input its data and simulation to the program. Thence making a comparison between the readings of electricity meter and the simulation program results. The research aims to determine the actual error rate in Design Builder program results. That happens by doing an actual study to electricity consumption of "EL-Wasta prep. School for Girls ", and compare it with the results of Design Builder simulation program. These studies be done by making daily field visit to the school building and reading its electricity meter monthly. Thence input school data to the Design Builder program and compare it with the actual results of meter'sreading, to reach for the error rate of the program results.

Introduction

There are many of thermal performance simulation programs and energy consumption in buildings, however that there are a few of these programs which can do a complete simulation to the building and its external casing. So the Design Builder program be chosen for this experiment, that it accredited by "The Housing and Building National Research Center". In addition to that it was used in Egyptian Energy code and uses (Energy plus & Visual DOE4) which been accredited by the United Kingdom since 2010.[1]

One of the researchers "engineer Mohammed Abd El Razik" in The Housing and Building National Research Center had made a study about Calibration "DOE4" which uses with Design Builder program, but he didn't make a calibration of "Design Builder program" in general.

This program provides an environment in which you can test out various design options for environmental comfort, energy consumption and visual appearance and an approach to natural ventilation allows detailed models of natural ventilation air flows with the minimum of effort.

There for it was necessary to calibrate the used program to know the factor of correction.

1- The effective factors on the simulation results difference from the building actual situation

Although the programs always have been tested and approved, before its usage from the oritical and technical includes "a used laws and rates", but also there are unnoticed hypotheses for each model which might be axiomatic. The reality of human behavior and the societies difference in our countries from analogical cases that leads to many variations. There are many of factors which affect result accuracy, just for example:

- The status of doors and windows while running air-conditioners (open or closed in any proportion).
- Case in fusion for doors and windows allowing air leaking.
- Time running air conditions and lighting in the absence of users in vacuum.
- Durations of power out age.
- The effect of clothing worn by users on the results (which can not be measured).
- The user physiological case weight (obesity), kind of activity, age, diet, health status and gender (male or female).

SO before we start to conduct simulation tests, we should check with the assumptions and effects prevailing in that country, zone and building, and measuring the difference between the coefficient of performance of the building in the program and in fact.

2- Overview about the program:

The design builder program calculates cooling and heating systems, by integration of mechanical and natural system. The program also calculates the amount of artificial light needed by the building to achieve visual comfort, by incorporating artificial lighting gradually as natural as needed during daylight hours. This program contains all the Egyptian climate data for the regions (city climate of each region), and gives results each hour which gives the user a detailed picture of the way of building performance.[2]

The following (figure 1) shows the usual arrangement for the performance of the simulation

process, Firstly, three dimensional models makers used for drawing the building and its components to the

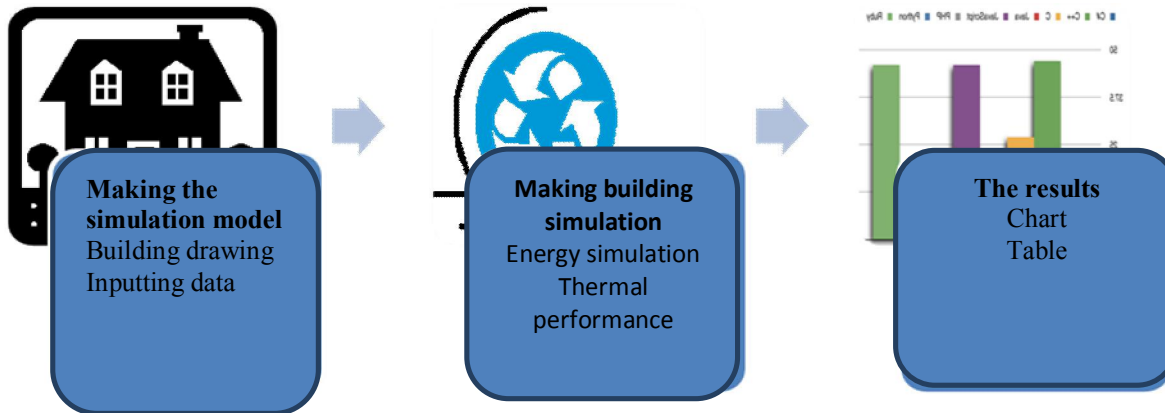application of simulation. Finally results come out in the form of a chart or table.

Figure 1. The steps of simulation in "Design Builder program", source researcher

3-   Calibration methodology;
This research discusses real studies of electricity consumption in "ELWasta prep school for Girls" to compare electricity consumption results from Design Builder simulation program with the real consumption. Therefor determine the actual error rate in program results,with the following steps:

• Making a daily field visit to the school building and definition the number of used electronic sets, lights and its usage hours.

• Reading school electricity meter mounthly, and defining reading compartion for knowing mounthly consumption.

• Inputting school data in Design Builder program with three dimentional drawing,in addition to inputting climate data,numbers of electronic sets,numbers of lights and its usage hours.

• comparing the results of the program to define the error rate on it.

4-   A detailed description of the condition of the building:
EL-Wasta Prep school for Girlsis located in" EL-Wasta –Beni Suef" Northen Upper Egypt province which includes "Fayom, Minia and Beni Suef".The building surrounded by streets from all directions and be in the middel of residential area. The building consistes of ground floor, a director office,some administative offices and W.C. then on first floor is a library, laboratory, an attached store to the lab and preparation room. Secondfloor consistes of three classrooms**,** there are five floors.

The building is a rectangular shape its dimentions are (width 7,5 m and length 35 m) in all it is 224 m^2, and the floor high is 3,5 m. The classrooms are located in the northern in dimentions 8*5 m for each class and an passage 2,5 m over the building length. The overtures measurement amount in northern elevation

about 28% (window of wall racho) from the whole elevation, which includes about eminent pillars that repeated each 4 m. The southern elevation is a carried passagee on pillars which contains the classrooms doors and has an upper window.as show in Figure 2 Figure 3.

Picture.1 for EL-Wasta Prep School, source researcher

4-1- The required data for making simulation model:
4-1-1- occupancy hours
In studing time working startes from 8 a.m, during the day the number of occupants is unchangeable, and ends at 2 p.m. After tow o`clock there is not any body in the buiding unless the cleaners till 3p.m, after that be only the resident school guard. (Table NO.1).

It has been identified the weekends (Friday and Saterday) also the legal holidays (Feasts and Events).

The classrooms are being occupied from 20 September to 30 June, 6 hours daily, but the administrative offices still working all the year.
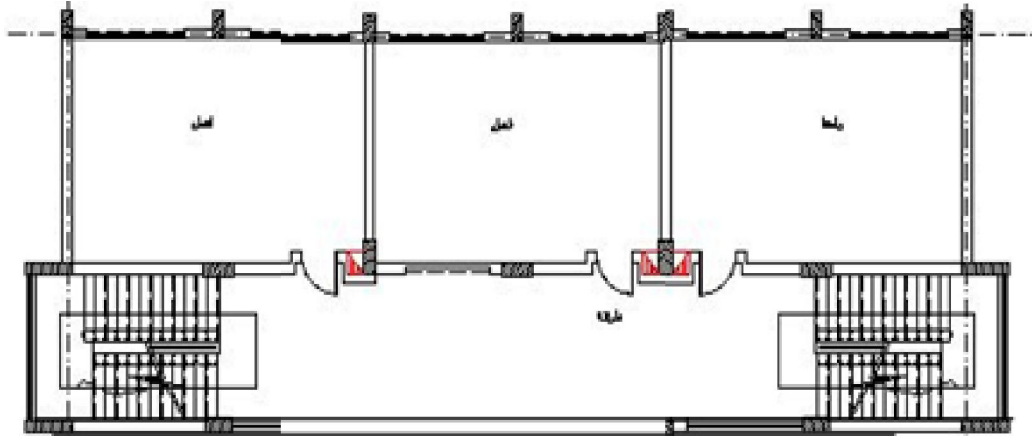
Figure 2. plan of school model, source General Educational Building organization (Beni Suef)
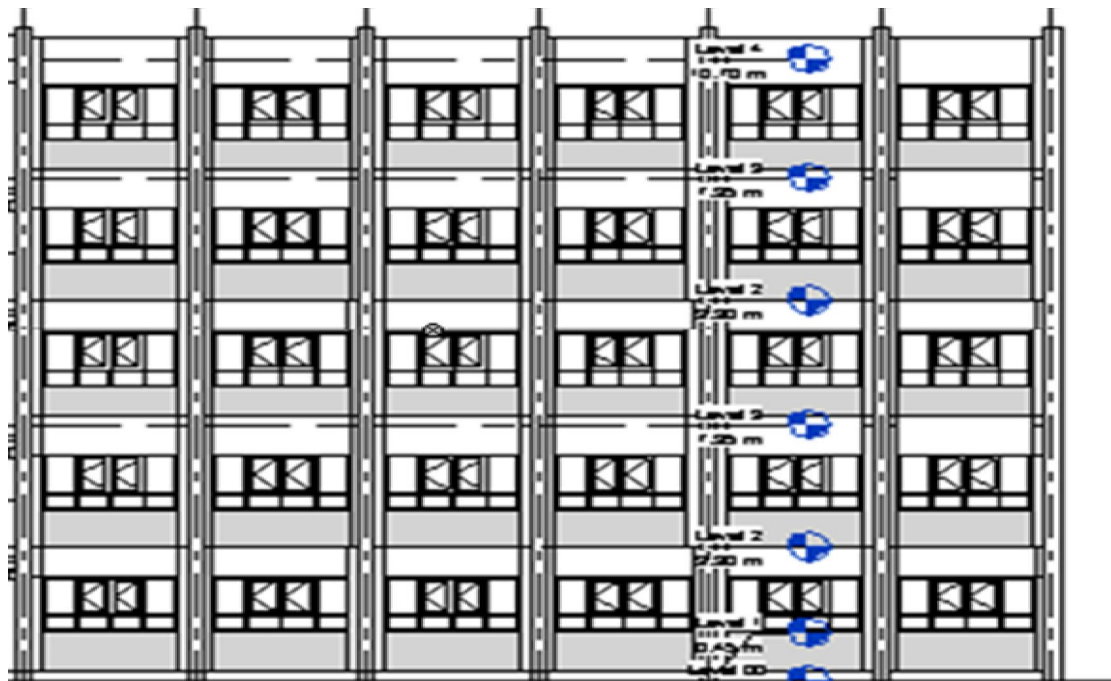
Figure 3. The northern elevation of the school building, source General Educational Building organization (Beni Suef)

The following table 1. explanins inputting working hours in the building on the program.

| Place Day	Educational space	Administrative offices	The guard room	Lay out
Saturday	Not working	Not working	Working from 6 a.m to 8 p.m	Working from 8 p.m to 6 a.m
Sunday	From 8a.m to 2 p.m	From 8a.m to 2 p.m	From 6 a.m to 8 p.m	From 8 p.m to 6 a.m
Monday	From 8a.m to 2 p.m	From 8a.m to 2 p.m	From 6 a.m to 8 p.m	From 8 p.m to 6 a.m
Tuesday	From 8a.m to 2 p.m	From 8a.m to 2 p.m	From 6 a.m to 8 p.m	From 8 p.m to 6 a.m
Wednesday	From 8a.m to 2 p.m	From 8a.m to 2 p.m	From 6 a.m to 8 p.m	From 8 p.m to 6 a.m
Thursday	From 8a.m to 2 p.m	From 8 a.m to 2 p.m	From 6 a.m to 8 p.m	From 8 p.m to 6 a.m
Friday	Not working	Not working	From 6 a.m to 8 p.m	From 8 p.m to 6 a.m
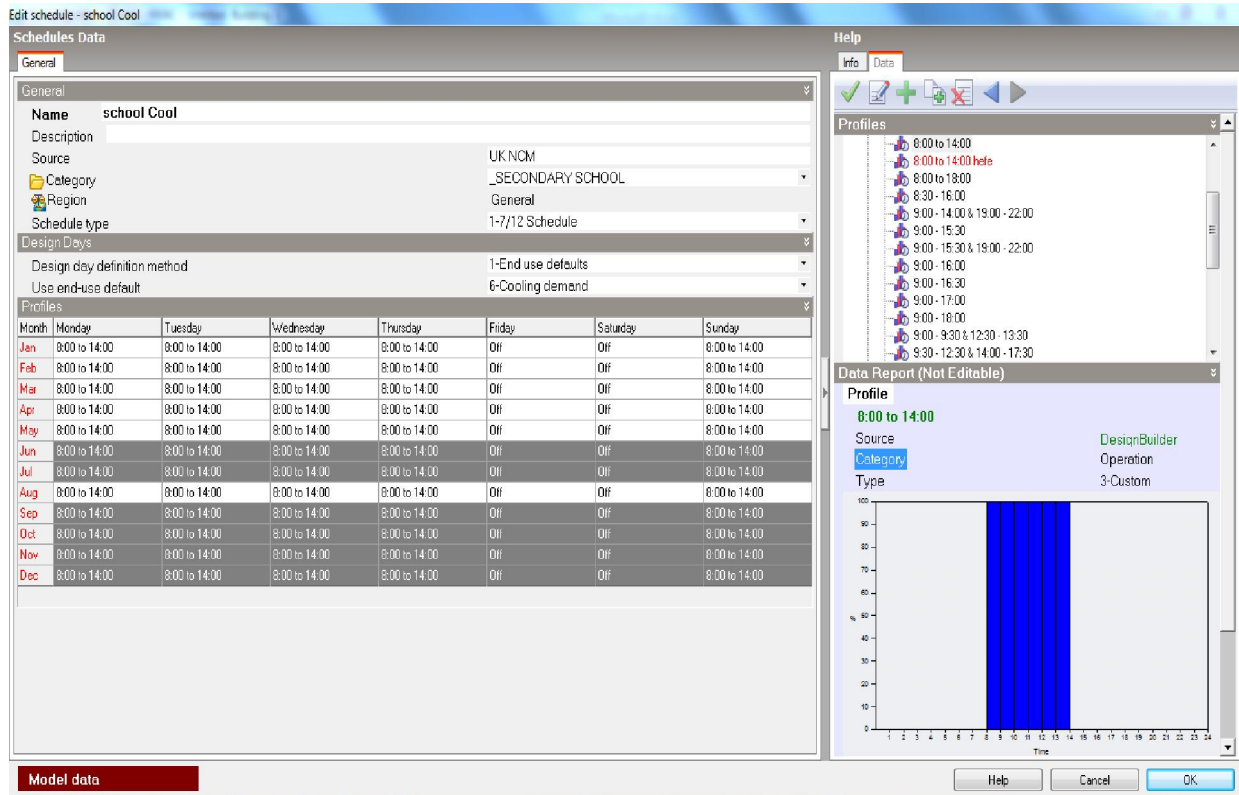
Figure 4. Window of edit schedule on program, source Design Builder program

4-1-2- Construction materials:

The following table 2 explains the materials used in finishing the external and internal walls of the building, and in the roofs between the floors.

Table 2. The finishing materials of the building, source General Educational Building organization (Beni Suef)

	Finishing
External walls	2 cm. paint + 25 cm. bricks + 2 cm. paint
Internal walls	2 cm. paint + 25 cm. bricks + 2 cm. paint
External roof	2 cm. tiles + 2 cm. cement + 5 cm. sands + 5 cm. concrete + 5 cm. insulation Polystyrene + 7 cm. concrete cement + 2 cm. insulation moisture Bitumen +15 cm. concrete slab +2 cm finishing
Internal roof	2 cm. tiles + 2 cm. cement + 5 cm. sands +15 cm. concrete slab + 2 cm. finishing
Ground Floor	2 cm. tiles + 2 cm. cement + 5 cm. sands +5 cm. concrete+ 2 cm. insulation moisture Bitumen+ 15 cm. concrete cement + debris

4-1-3-The opening:

There are opening in northern frontage which each one is 7, 8 m^2 that be 28% from "Window to Wall racho" and 20% from "Window to area flower racho". The following table explains openings found in various frontages of the school building.

4-1-4- The lighting:

There are 4 Fluorescent lights in each classroom picture 2, some classroom have a saving electricity lump, in addition to searchlights on school rail. The following table 4 explains usage hours of the lighting.

4-1-5- HVAC Systems:

The school uses natural ventilations Picture 2. in addition to roof fans in classrooms and offices Picture 3. and there are air conditions in computer and fair laboratories.

Table NO.3 description of school building openings, source General Educational Building organization (Beni Suef)

Openings	Description
Openings in northern elevation (classrooms)	Single glass window its dimensions 2,60*1,5 m fixed,1,3 *1,1 m movable
Openings in southern elevation	Single glass window its dimensions 2,60*1,5 m fixed, 1,3 *1,1 m movable
Openings in eastern elevation	NOT found
Openings in western elevation	NOT found

Picture 2. the lightings in school, source the researcher

Picture 3. the natural ventilation, source the researcher

Picture 4. The roof fan in classrooms, source the researcher

4-1-6- sets and equipment used in school:

The researcher had done a daily field visit to the school for six months from July to January, and she identified the usage hours of all sets. Following table explains the used sets and its usage hours. Picture 4.

Picture 5. The sets in computer lab, source the researcher

Table 3. Clarify working hours of the sets and equipment, source the researcher.

Place	lighting		Artificial ventilation				Sets and equipment			
	Lights	Usage hours	Fans	Usage hours	AirC.	Usage hours	Computer	Usage hours	Sets	Usage hours
Classes	4 fluorescent lights 120 cm.	6	2	6	_	_				
Library	4 fluorescent lights120 cm.	6	2	6			1	6		
Computer lab	4 fluorescent lights 120 cm.	6	2	3	1	3	20	6		_
Multimedia lab	4 fluorescent +2saving lights 120 cm.	6	1	3	1	3	1	3 h +30min	Data show+ screen + video +TV	1 h +40 min
Administration	2 saving lights	6	1	6					10 water heater	
layout	3 searchlights on school rail	10							Microphone +bell	15min
House handcraft room	2 saving lights	6	2	6	_	_	_	_	Refrigerator+ sewing machine	24h
Minimarket	saving light	6	1	6	_		_		Refrigerator+ freezer	24h
Guard room	saving light	8	_		_					

Table 4. Number of usage hours of sets and equipment during the week, source the researcher

DAY	lighting		Artificial ventilation						Sets and equipment	
	Lights number	Usage hours	Fans numbers	Usage hours	Air Conditions numbers	Usage hours	Computer numbers	Usage hours	Sets and equipment	Usage hours
Saturday	1	8	_	_	_	_	_	_	2 Refrigerator+ Deep freezer	24 h
	3 search lights	10							2 Refrigerator+ Deep freezer	24h
Sunday	24	6	11	6	2	3	22	6	Data show+ screen +video +TV	1h+40min
	3 search lights	10							2 Refrigerator+ Deep freezer	24h
Monday	24	6	11	6	2	3	22	6	Data show + screen +video +TV	1h+40min
	3 search lights	10							2 Refrigerator+ Deep freezer	24h
Tuesday	24	6	11	6	2	3	22	6	Data show + screen +video +TV	1h+40min
	3 search lights	10							2 Refrigerator+ Deep freezer	24h
Wednesday	24	6	11	6	2	3	22	6	Data show + screen +video +TV	1h+40min
	3 search lights	10							2 Refrigerator+ Deep freezer	24h
Thursday	24	6	11	6	2	3	22	6	Data show + screen +video +TV	1h+40min
	3 search lights	10							2 Refrigerator+ Deep freezer	24h
Friday	1	8	_	_	_	_	-	-	Data show + screen +video +TV	_
	3 search lights	10								

5- The results of Design Builder program calibration:

The following table explains the electricity consumption results by reading electricity meter and

Design Builder simulation program from July 2014 to January 2015, which appears the coincidence between the real electricity consumption and the Design Builder results. The highest error rate is 3,5 %and the least error rate is 2,9 %, therefore the average rate is 3,17

%,which gives a good sign about the data and the ability of using the program in analysis of various alternatives for energy conservation in study case and determines the extent of saving in consumption. Table 5 Picture 5.

Picture 5. Electricity consumption results by reading electricity meter, source the researcher

Table 5. Electricity consumption results by reading electricity meter and Design Builder simulation program from July 2014 to January 2015, source the researcher

Months	Electricity meter readings (K.W. H.)	Electricity consumption by Design Builder	Error rate
July 2014	483	466	-3,5 %
August 2014	451	435	-3,5 %
September 2014	479	462	-3,5 %
October 2014	343	332,7	-3%
November 2014	255	247,6	-2,9 %
December 2014	203	196	-3 %
January 2015	214	207,58	-3 %

Conclusion:

The research had made a calibration of (EL Wasta prep school for Girls) through comparing the electricity consumption results by reading electricity meter and Design Builder simulation program from July 2014 to June 2915, which appears the coincidence between the real electricity consumption and the Design Builder results. The highest error rate is 3,5 % and the least error rate is 2,9 %,therefor the average rate is 3,17%,which gives a good sign about the data and the ability of using the program in analysis of various alternatives for energy conservation in study case and determines the extent of saving in consumption.

The recommendations:

1- The research recommends using the Design Builder program which has an acceptable error rate (3, 17 %).

2-The research recommends adding the error rate to the program results to have the actual results.

3-The research recommends making a calibration to the simulation program before using it, to reach the error rate in it.

References
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