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INTEGRATION OF PERFORMANCE BASED MODELING TECHNIQUES WITH BUILDING DESIGN METHOD (INDUSTRY/FACTORY) CONSIDERING ENERGY EFFICIENCY IN BANGLADESH

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Climate changing has been a debated issue during the last few years. Some institutes in different countries have worked on this subject. Several future climate predictions have been generated. Each future climate is based on some assumptions and consequently has some uncertainties. These uncertainties are dragged to the building simulation results by using the climate data for assessing the future performance of buildings. Bangladesh is newly a developing country. Many more construction is going on in full swing now days. This rapid construction is changing our earth surface very quickly. So that it increases heat on earth surface, energy consumption, decrease the comfort level. The answer to this challenging situation is the adoption of a holistic design approach, whereby the different disciplines required is brought together and interacts since the first steps of the design process. This study revealed the present implementation status of factory building sector energy standards in Bangladesh, implications for sustainable energy efficient designs in factory building and increasing demand for sustainable energy efficient industrial building.

Key words: Building Energy Use; Building Performance Modeling; Industrial Building

1. INTRODUCTION

Factories in Bangladesh have been heavily criticized over the last 30 years for the working conditions in which employees must labor. High internal gains from artificial lighting, poor natural lighting system and equipment produce an intolerably hot work environment and energy consumption is high. Bangladesh is one of the largest products exporters in the world. This factory building has been expanding rapidly since the late 1970s. Many purpose built factories have their own compliance to maintain the quality. Among the environmental compliances recommended Illumination condition, thermal comfort and reduce energy consumption are one of them that must be ensured. This paper consists 3 parts such as;

(i) The status of energy standards for factory buildings in Bangladesh;

(ii) Approaches to standards development in view of energy efficiency

(iii) Implementation and energy simulation.

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Energy saving did not happen in industrial sector in our country. Extra energy consumption (28.18 MTOE) in industry sector came from structural change (S-effect) and intensity change (I-effect) with amount of 16.39 and 11.79 MTOE, respectively.

This paper investigates the implementation status of factory building energy standards in developing countries and its implications for sustainable energy efficient designs in building. Important elements of the research that are described in the paper are:

• identifying the role factory building simulation can play at the different stages of design;

• developing a model description that evolves through the design process as the factory building design becomes more highly specified;

• simplifying the user interface at the early stage of the design where rapid feedback is required and where most impact can be made on the factory building's energy and environmental performance;

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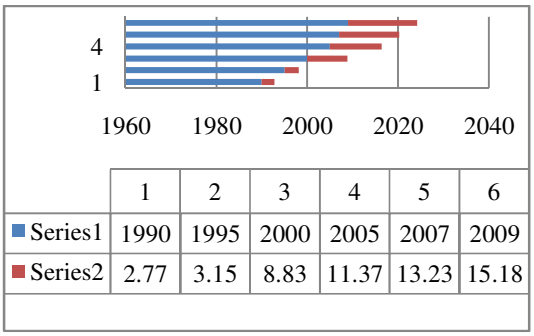
• customizing results presentation to be appropriate for the particular stage of design; and
• implementing these simulation concepts, observing their acceptability, and addressing quality assurance and training issues.

In this Fig. 1, we can see the energy demand changing rapidly in our industrial sector. From 1970 to 2020 the energy demand of the industrial sector in Bangladesh will be almost 10 times increases.

So what can we do as professional bodies? There may have much kind of solutions. Building performance modeling while planning or designing a building may be one of the solutions to get rid of this kind of problem.



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Series1	1990	1995	2000	2005	2007	2009
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Fig. 1: energy consumption in the industrial sectors in Bangladesh Source: Research Journal of Applied Sciences

In Fig. 2 we can compare the ratio of energy demand increase day by day. And in 2010 it is highest. In the long run, we need more energy from the limited resources and it will cause a tremendous problem for our nation.

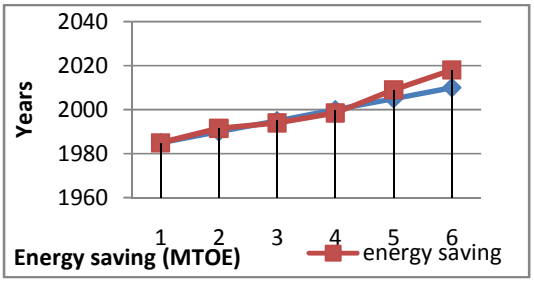

Fig.2: Energy demand of industrial sectors in Bangladesh Source: Research Journal of Applied Sciences; Year: 2010 | Volume: 5 | Issue: 2 | Page No.: 85-91

The overall building behavior will be influenced by numerous climate parameters, including sun, wind, water, and geotechnical factors. The sun influences shading, orientation, and views of the building. Wind introduces concepts of protection, shelter, and energy capture. Energy Conservation factory Buildings are very effective for restraint of global warming, because they can reduce CO2 emissions in building operation, which account for 70% of Life Cycle emissions.

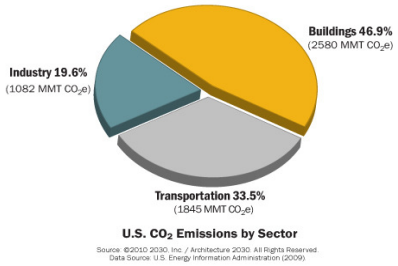

Fig. 3: US co2 emission by sector

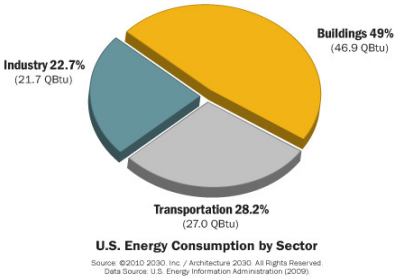

Fig. 4: US energy consumption by sector

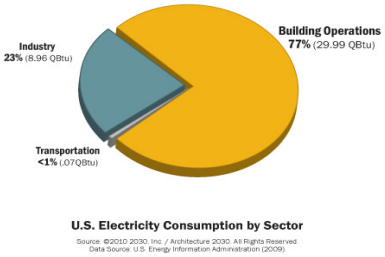

Fig. 5: US electricity consumption by sector sources: architecture 2030, energy international administration (2010)

From fig.3 – 5 we can notice that in US energy consumption is 22.7% in industrial sector and the whole building effect is almost 49% .the electricity consumption rate is about 23% and co2 emission is almost 19.6%. So now a day it is a big deal.

An essential condition for industrial development is uninterrupted supply of energy. Although the installed capacity for generation of electricity in

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the country is 2908 megawatt and energy consumption is about 25% in the industrial sector and takes the second position of energy consumption (Fig. 6), the actual production does not exceed 2160 megawatt as against the peak demand of 2200 megawatt. The average level of system loss is still as high as 33.3%. The demand for power will increase by 300 MW annually and an investment of about Tk 110 billion up to the turn of the century will be needed to meet it.

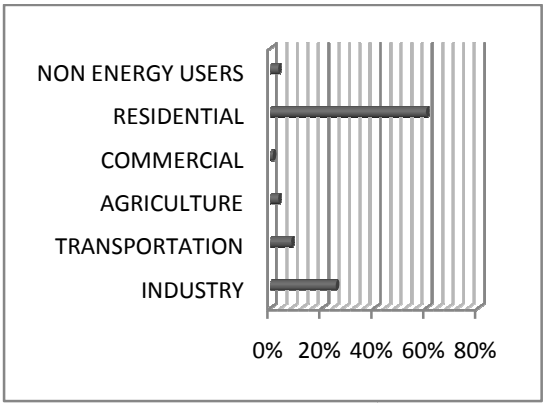

Fig. 6: Bangladesh electricity consumption by sector sources: power development authority, Bangladesh

2. IMPORTANCE OF ENERGY SIMULATION IN ARCHITECTURAL DESIGN

In early design stages, either in new or retrofit designs, one can estimate the energy consumption of the building being designed by using hand calculations. However, an energy simulation program can help the designer have more reliable predictions because it is able to simulate the building, the weather conditions that obviously influence the thermal behavior of the building, and the operating schedules of the building.

Energy simulations can then help the designer validate the preliminary estimation of the building's energy consumption and correct some of the architectural features of the building, and the mechanical systems, to improve the energy performance of the building. The building's form and thermal characteristics largely run the amount of energy consumed by a building. Thus, it is the building designer who has the primary control over the building's energy use. When an architect starts to design a building, she or he is simultaneously starting the design of the heating, cooling, and lighting of the building. To avoid major flaws of the design, an architect needs to include the evaluation of the building's energy consumption in the earlier stages of the design process. If energy efficiency is not adequately considered during these stages, higher operating cost will accrue over the life of the building.

3. IMPACT ON ENVIRONMENT

Building performance modeling will create new knowledge and assist in capacity building by improving our understanding about energy efficiency on climatic adaptation and mitigation. This will create more awareness to take more effective actions for mitigating climate change, thereby making sustainable development feasible for green industry development in Bangladesh. It also Generate innovative knowledge. This knowledge will impact on national programs and strategies for climate change adaptation and mitigation.

4. GAPS FINDING IN DESIGN PROCESS (FACTORY BUILDING)

A worker's ability to do his/her job is affected by working in hot environments. One of the most important conditions for productive work is maintaining a comfortable temperature inside the workplace. Of course the temperature inside the factory varies according to the season and several methods can be used to address the problem.

Natural cross ventilation is another important factor for a factory building. Instead of natural cross ventilation extra cooling and heating load is needed for a factory building.

Most of the factory building in our country has no or less option of natural ventilation system, use of daylight, water efficiency techniques, no observation about indoor air quality and energy efficiency building envelop. On the other hand inside a typical factory, noise may come from a number of different sources such as the sewing machines, weaving looms, compressors, radios, background noise, etc. The noise, in the form of

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sound waves, is transmitted directly through the air and reflects off walls and ceilings as well as passing through the factory floor. It can be easily removed by the way of simulation process.

In Fig. 7 the diagram is presented the basic 3 gap of factory building design. In our country there is no consideration about local climate, building shape, orientation, no consideration about passive design process.

Most of the factory building owner want just make a floor for production and for this reason human being is like a machine nothing else here. Health hazardous condition and need extra energy for maintaining this factory is a common scenario in our country like Bangladesh.

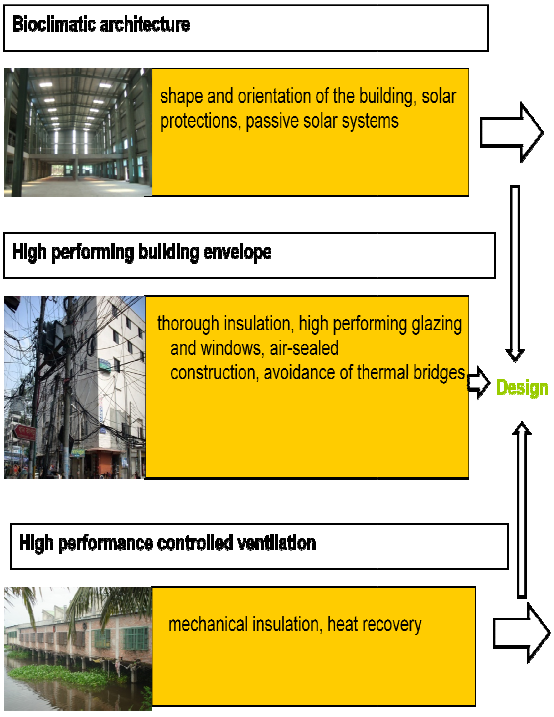

Fig. 7: the condition of present factory in Bangladesh and gaping element

5. SIMULATION IN THE DESIGN PROCESS

From Larry O. Degelman, Professor of Architecture, Texas A&M University we come to know to establish a holistic design approach with simulation having an input at all stages it was necessary to determine the design approach of the architecture practice used as a analysis bed. The approach developed was also compared with related approaches in the published literature. The RIBA design plan of work (RIBA 1995) identifies three main building design stages: •Outline Design Stage • Scheme Design Stage • Detailed Design Stage. Different design objectives and scopes can be observed in the different factory building design stages.

At first in outline design stage a concept based on feasibility studies is prepared. It shows the design Analysis and options considered, it can include diagrammatic analysis of the requirements on the site, solutions to functional and circulation problems, relationships of spaces, massing, construction and environmental methods and a cost appraisal to enable an approximation of construction cost. This design stage is extremely time constrained. Elevation treatment, materials selection, construction and environmental analysis then are taken place in out line design stage.

In term of environmental analysis; Simulation will focus on problem areas or on typical factory building sections. Now the approved Scheme Design solution is worked through in detail. Detailed design drawings are produced for coordinating structure, services and specialist installation. Internal spaces may be detailed to include fittings, equipment and finishes.

At this design stage the application of simulation relates mainly to engineering issues and it will be experts using the tool. They will use simulation for purposes such as designing a natural ventilation strategy (sizing of openings, establishing control strategies, confirming minimum and maximum air flow) or to model other building services applications such as chilled construction systems or air conditioning systems.

In Fig. 8 a basic structure is shown for whole design evaluation process to see how simulation is used in design.

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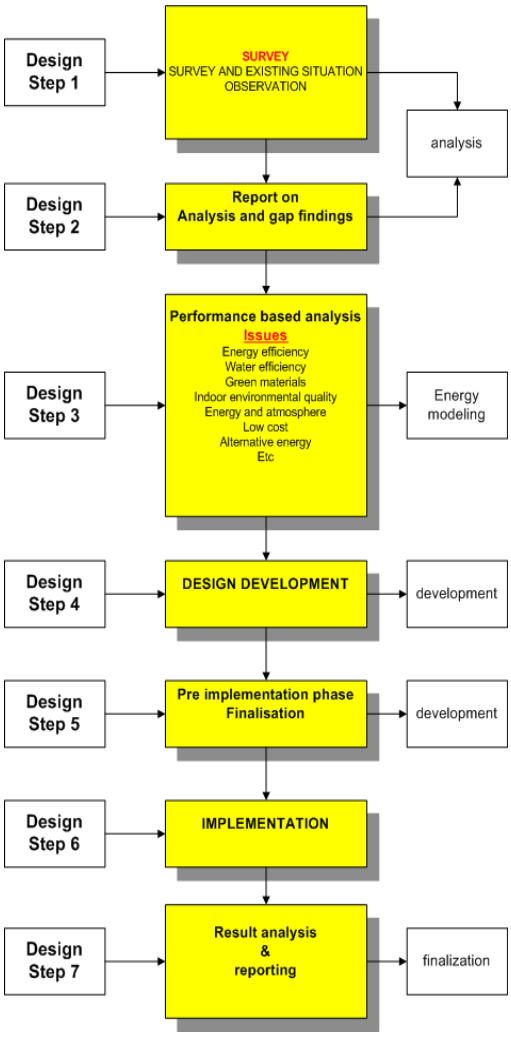

Fig. 8: structure of the design evaluation process BIM (Building Information Modeling) system

6. PARAMETERS EVALUATED BUILDING PERFORMANCE TOOLS

Simulation parameters also communicate more to the factory building envelope (glazing properties, ventilation rates) and whole building per year energy cost. The designer will be interested in an indication of the energy consumption that can be expected from the building. Simulation can also point out problem areas, identify parameters that cause the problem and assess the scale of the problem. Various types of simulation engine (tools) can be used for these purposes and using the same simulation tool throughout the design process has additional advantages. It is possible to pass a model directly from one design stage to the next one. It is easier to tackle environmental issues in a holistic approach. Some energy simulation engine and their functions (applications) are mentioned here such as; Ecotect, Energy Plus, Dia lux, E-Spr, Radiance, Design Builder, etc. From Table. 1, it is noticed that various variables depends on the three design stages. And it comes one after another and need analysis for every component to make a factory green.

Design stage	Parametric consideration
Out line design stage	Orientation, U-values, Heat recovery systems, Air change rate
Scheme design stage	Detailed analysis, Material adjustment in overheating areas, Lighting strategy
Detailed design stage	Different heating systems Different cooling systems: Mechanical, ventilation

Table. 1: chart various design stage (Christoph Morbitzer, 2001)

7. MODEL CREATION

A number of key developments are part of the user Outline Design Stage (ODS) Interface.The program interface is structured to permit a step-by-step, rapid input procedure for the base case model and design options. 3D CAD software is used to define the model geometry. Detailed support databases are provided that distinguish building types, room function and zone location with the emphasis on rapid user selection (Joyce Carlo, 2003)

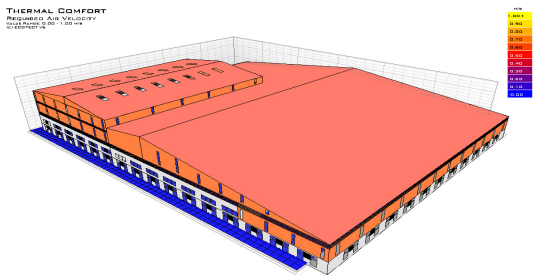

Fig. 9: a physical factory building computer generated model by Ecotect

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8. RESULTS ANALYSIS

Presentation of performance data is another vital element of building simulation interface design. This should help the designer to judge the environmental performance of the design and point out potential problems in the building. This includes the following key components:

• Ranking of the results against benchmarks.

• Identifying areas in the building that case poor performance.

• Identification of the reasons for unsatisfactory performance.

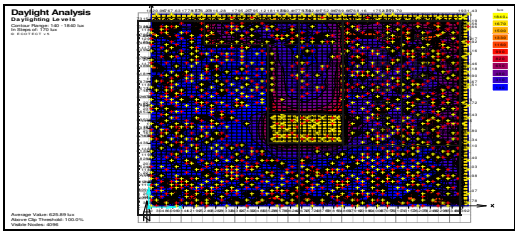

Fig. 10; daylight analysis model by Ecotect simulation tool

After performing the simulation, hourly result data is read into the database structure. The software then determines annual energy figures and compares them against benchmarks. It also View the energy flows in the building depending on, for example, time of day, external temperature, occupancy, only certain zone(s) etc.

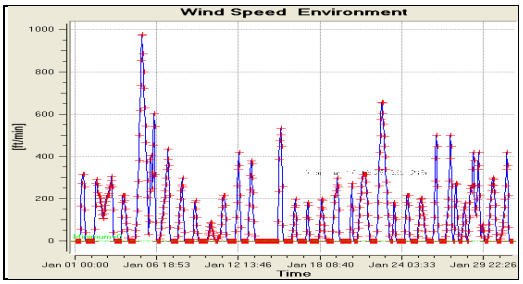

Fig. 11; win speed analysis 1 by Energy plus simulation tool

9. CONCLUSION

Building simulation is currently not an integrated element of the design process. Integrating modeling would raise awareness of energy and environmental issues and give it an adequate status in design decision making.

Finally it may be noted here Building performance simulation modeling has come a long way since the early seventies. In other developing countries, this type of integration is going on in full swing for their betterment of environmental aspect and them able to make the zero carbon community. We have to think about "plus o2 community" development instead of "zero carbon community" for our upcoming generation so that they can live in green space with the help of this kind of prediction techniques.

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