Promoting Building Energy Efficiency through Performance-based Standards: Is it a Challenge?

By

Priyantha Bandara

Senior Lecturer – General Sir John Kotelawala Defence University, Sri Lanka

&

Rahula Attalage

Senior Professor – University of Moratuwa, Sri Lanka

Navigation

- Background and Issues
- Performance Standards of Buildings
- Performance-based Approach
- A Case Study of Performance Evaluation
- Challenges and Issues
- Conclusion

Background and Issues

- Buildings account for nearly 40% of the global energy consumption, and almost 50% of carbon dioxide emissions annually.
- Buildings last decades
  - ❖ Decisions today have a long-lasting impact on the future global energy consumption and emissions.
- People spend almost 90% of time inside buildings.
- Indoor pollutant levels may be 2-5 times higher than outdoor levels.

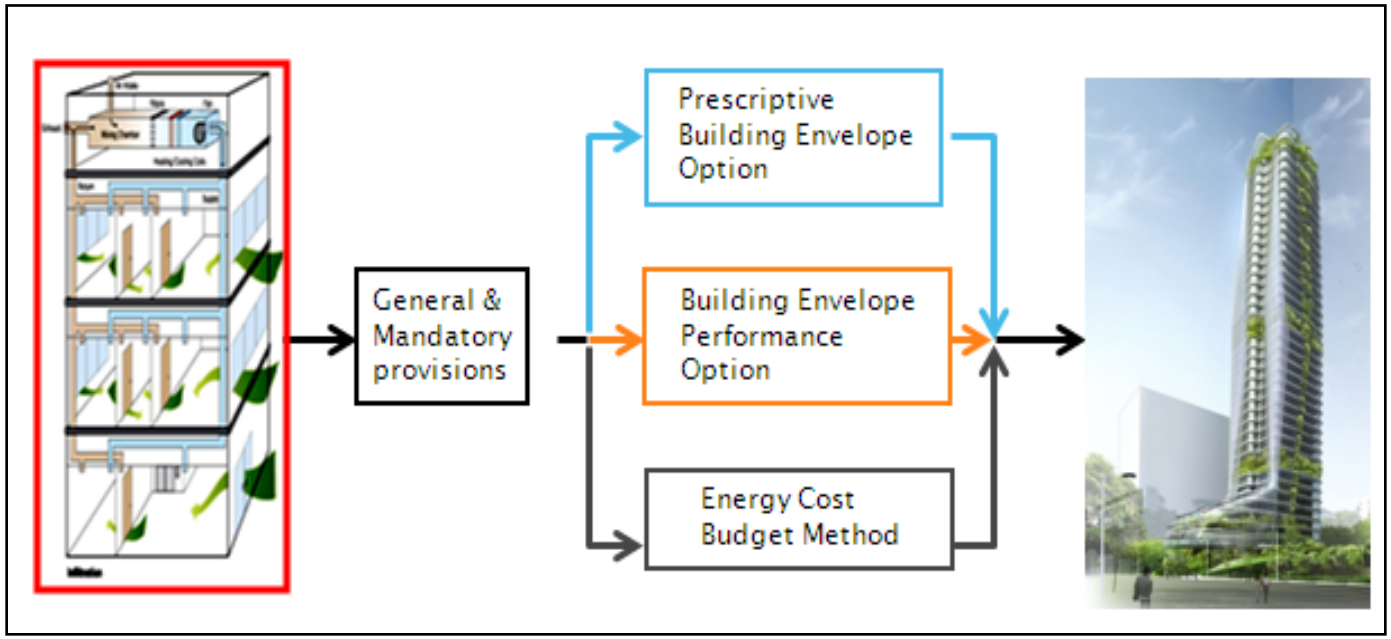
Background and Issues contd..

- The built environment is booming all over Asia:
  - ❖ China: Constructing almost half of the world's new buildings
  - ❖ India: Buildings doubled from 2000 to 2005

- Buildings in Asia are consuming more energy and producing more Green House Gas emissions and predicted to rise at a rapid rate during the next decade:
  - ❖ Share of the world's total energy consumption: 1971- 3.7%; 2004-7.3%; 2030: 11.2%

Performance Standards of Buildings

- Building energy efficiency policy measures established in terms of fiscal, financial and regulatory.
- Building performance standards categorized into:
  - ➢ Prescriptive
  - ➢ Performance-based



Source: Extract from ASHRAE documentation

Performance Standards of Buildings contd..

Prescriptive

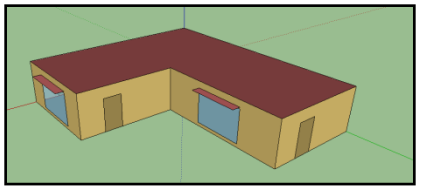
- Stipulates mandatory and prescriptive criteria for generic building elements, equipment and energy supply conditions to be complied by the user
- Includes Building envelope, HVAC equipment, Lighting system, Hot water system, Power supply and Auxiliary equipment etc.

Performance-based

- Compliance is based on stipulated performance metrics that have to be established by pre-determined methods
- Utilizes design tools and building performance modelling techniques
- Enables optimization of performance of buildings through which substantial savings can be achieved while meeting the design intent

Performance-based Approach

CAD Tool → Computational model of the base building design



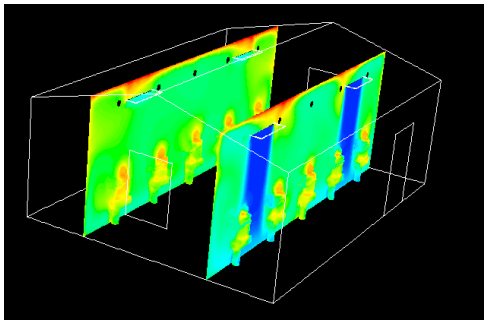
Weather Data → Whole Building Simulation Tool

EnergyPlus eQUEST

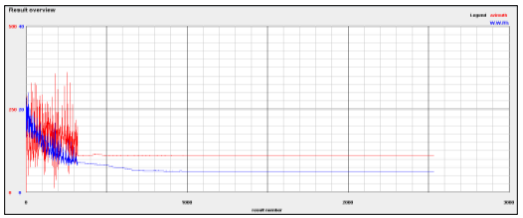
Objective Function
(Energy Consumption, Thermal Comfort, IAQ etc.)

→ Optimization Tool ← Optimization Algorithm

MATLAB GenOpt Generic Optimization Program



Optimal Building Design

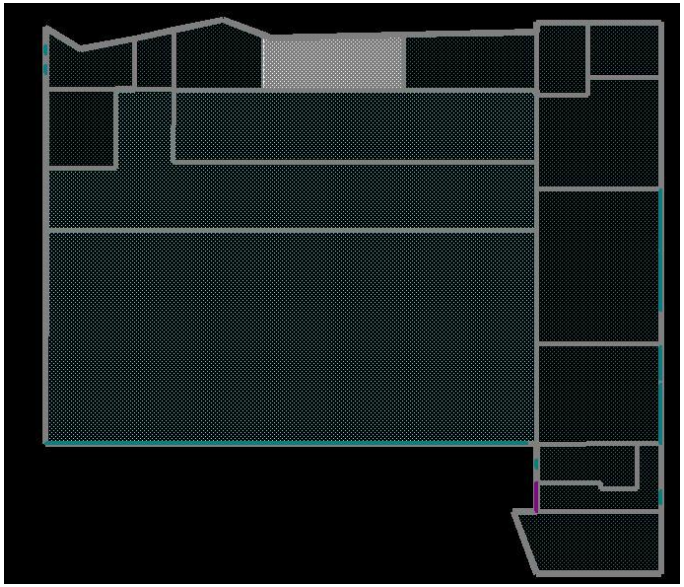


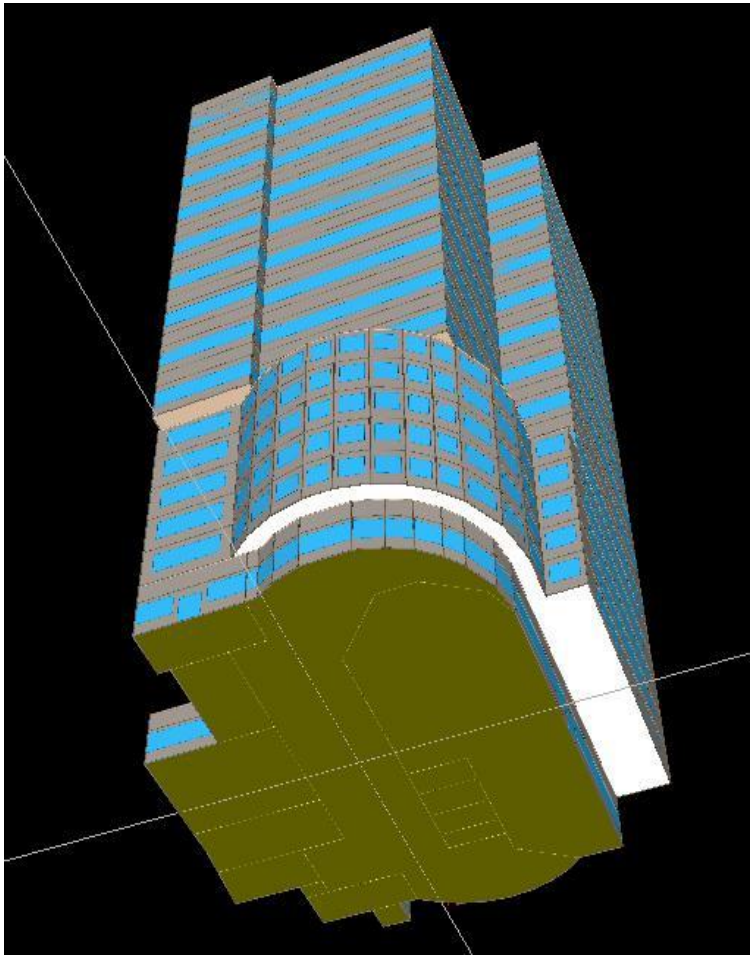
A Case Study of Performance Evaluation

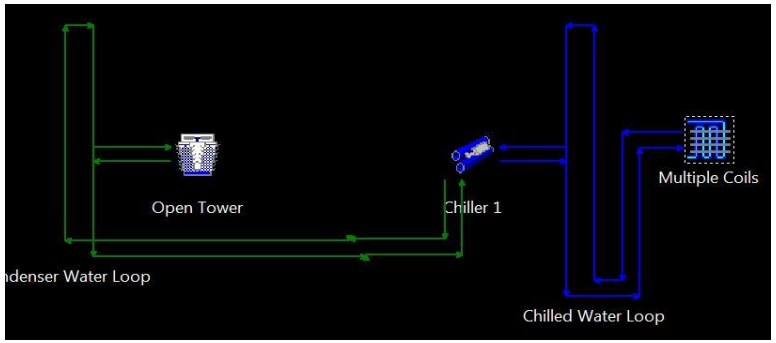
- A two-storey building which has an automobile repair workshop and office spaces.
- 6846 Sq. ft of conditioned area.
- Window to Wall Ratio (WWR) - 25.45%
- Climate Zone 1A

Building Component		Prescriptive	Performance based
Envelope	Walls	U-0.705 W/m^{2}K	Not specific
	Roof	U-0.360 W/m^{2}K	Not specific
	Floor	U-1.986 W/m^{2}K	Not specific
	Glazing	U-6.81 W/m^{2}K, SHGC-0.25	Not specific
Lighting	Interior	Space by Space Method	Through Lighting simulation
HVAC System		Minimum equipment efficiencies	Through HVAC Simulation and Computational Fluid Dynamics

A Case Study of Performance Evaluation Contd..







A Case Study of Performance Evaluation Contd..

Energy Consumption per Annum (kWh)			
End Use	**Prescriptive Approach**	**Performance based Approach**	**Percent Energy Savings per Annum**
Interior Lighting	48,474	29,611	38.9%
Task Lighting	1,430	1,430	-
Receptacle Equipment	131,461	131,461	-
Space Heating	0	0	-
Space Cooling	92,890	53,506	42.4%
Heat Rejection	0	2,740	-
Pumps & Auxiliary	0	12,531	-
Fans - Interior	53,377	2,435	95.4%
Exterior Usage	2,935	2,935	-
Total	**330,567**	**236,649**	**28.4%**

Challenges and Issues

- Acceptance by administrative authorities
- High capital cost of high-end hardware and software
- High computational power requirements
- Training on modelling tools, coding, optimization methodologies etc.
- Interoperability of tools
- Validation of results

Conclusion

- Standards are found to be an effective energy efficiency improvement strategy for buildings.
- Prescriptive standards establish minimum energy performance levels.
- Performance based method is highly effective than the prescriptive approach but demands for an additional effort.
- Modelling and simulations provide the necessary framework for enhancing performance of buildings over prescriptive methods and enables making vital decisions at the design stage.

Thank You