DETERMINING THE EFFECT OF BUILDING GEOMETRY ON ENERY USE PATTERNS OF OFFICES DEVELOPMENTS

Category: Academic, MBSc

Major research project, Individual

Location: Toronto, ON, Canada

Year: 2012

Optimization of energy is a crucial factor in the design of office buildings. Decisions made at the early design stages of a project that affect building geometry, orientation, and glazing levels can have a significant impact on its lifetime energy performance. Effective guidance will help designers to contribute toward sustainable solutions.

OBJECTIVE

• Exploring the influence of building geometry on energy consumption of office spaces

• Identifying the importance of ‹shape› compared to building envelope factors: window to wall ratio (WWR) and external shading devices

IMPORTANCE

The findings are expected to provide useful guidelines to the architects to utilize building geometry as an energy saving measure while designing workplaces.

METHODOLOGY

Phase 1: Parametric analysis
- Geometry
- Window to wall ratio
- Shading design

Phase 2: Energy simulation
- Space heating
- Space cooling
- Interior lighting

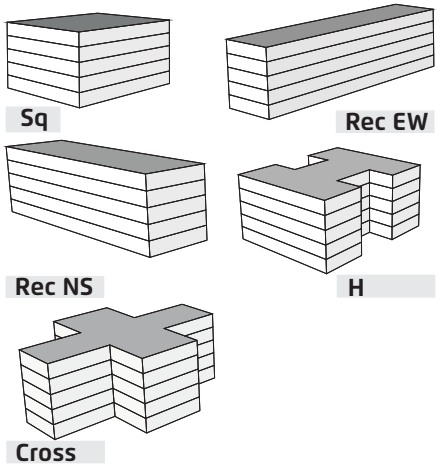
Phase 3: Result analysis
- Impact of design parameters on energy demands
- Dominance of design parameters on energy demands

GEOMETRY: Square, Rectangle elongated on East-West, Rectangle elongated on North- South, H- shape, and Cruciform

CLIMATE: Toronto, ON, Canada

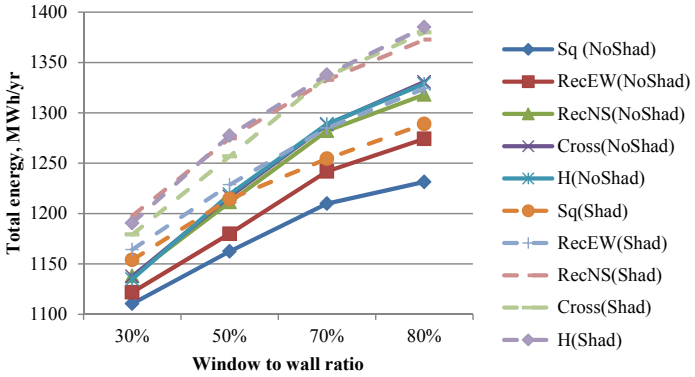
BUILDING FLOOR AREA: 6000 sq m

ENERGY MODELING SOFTWARE: IES Virtual Environment (Modules: SunCast, Radiance, and ApaceSim)



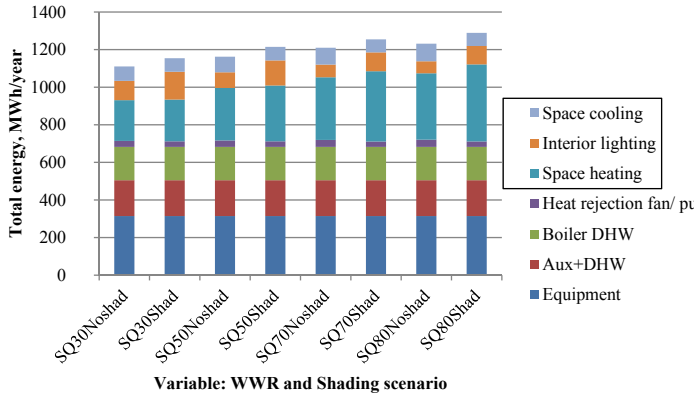
3D images of archetype buildings

RESULT 1: The increase of energy with respect to geometry is much less than the energy use for WWR.



Total energy results of five archetypes for ‘no shading’

RESULT 2: Heating energy makes up the largest proportion of the total energy usage.



Annual energy results of archetype ‘Sq’

RESULT 3: The most compact form has the least total energy consumption.

Archetype buildings	Compactness F/E	Compactness V/S	Total energy, MWh/year
Sq	1.51	4.64	1110.5- 1289
Rec EW	1.28	4.09	1121.8- 1324
Rec NS	1.28	4.09	1137.8- 1372.6
H	1.214	3.9	1137.5- 1380
Cross	1.214	3.9	1384- 1385

F/E increases; V/S increases; Energy increases

V/S= volume/ surface area (wall+ roof+ ground)

F/E= usable floor area/ above grade enclosure area(wall+roof)

CONCLUSION

• WWR has a stronger impact on the energy use pattern of a building than its shape.

• With more fenestration, energy usage of different forms varies within a larger range compared to the forms with less fenestration.