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Design of Green Building

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***Abstract*— The 4th Assessment Report from the Intergovernmental Panel on Climate Change (IPCC) has shown that buildings have the highest potential to reduce carbon emissions. This is due to the large consumption of energy within buildings. With the use of the right design and green technologies, a considerable amount of both energy and economic savings can actually be achieved. Buildings have the highest potential to reduce carbon emissions (4th Assessment Report, Intergovernmental Panel on Climate Change).**

In response to broad concerns regarding the environment and climate change, Green Buildings are becoming much more common and are increasingly in demand by building owners and occupiers. As a result, they are featuring more prominently in the portfolios of most building developers, architects and engineering consultants. The current green trends are quickly becoming the new standard. Current developments that do not follow these trends will find themselves becoming obsolete and will need upgrading or replacing, or risk losing value, Green Building Design can future-proof a development. This paper deals with the lower the WWR. The lower the WWR, the better the ETTV/RETV. Opaque enclosures generally resist heat transfer better than glass, reducing window size means more of the outside heat is prevented from being transferred inside because of the solid wall .provide glazing with where it is effective for views or daylight . Avoiding heat gains can be addressed by creative façade design, which should vary as function of the orientation.

***Index Terms*— Building Envelope, Overhang, Glazing, Green Building.**

I. INTRODUCTION

As a vast country with limited resources and growing needs, we have to use our land, water, energy and other resources prudently, pragmatically and with an eye on the future. This way, we ensure that Indians can enjoy both economic growth and a good living environment for ourselves, and for the future generations.

Last year, the Inter-Ministerial Committee on Sustainable Development (IMCSD) set a target for India's built environment: By 2030, 50% of the existing buildings in India are to achieve at least the IGBC Green Mark certification rating. In terms of energy efficiency, the Committee set a target of 35% reduction from the 2005 level by 2030.

To support the IGBC targets and the strategies put in place, the Building and Construction Authority (BCA) formulated the 2nd Green Building Master plan to step up its efforts in delivering a sustainable built environment.

This project provide useful information on sustainable building design, attributes of green buildings, as well as the latest green building technologies and design strategies and approaches. They are intended for building owners, architects, engineering consultants, and all the parties in a building project, to help them better appreciate the various issues involved in delivering a green building.

In this Report we present the importance and benefits of integrated and passive design and the adoption of energy efficient strategies such as natural ventilation and building greenery in the early design stage.

We have gone past the point where going "green" is an option. It has now become an absolute necessity. We hope, through this work of our research should inspire all stakeholders in the industry to make a concerted effort to improve the performance of our buildings in Since the Industrial Revolution, the world has witnessed incalculable technological achievements, population growth, and corresponding increases in resource use. As we enter a new century, we

are recognizing the "side effects" of our activities: pollution, landfills at capacity, toxic waste, global warming, resource and ozone depletion, and deforestation. These efforts are straining the limits of the Earth's "carrying capacity"—its ability to provide the resources required to sustain life while retaining the capacity to regenerate and remain viable.

As the world's population continues to expand, implementation of resource-efficient measures in all areas of human activity is imperative. The built environment is one clear example of the impact of human activity on resources. Buildings have a significant impact on the environment, accounting for one-sixth of the world's freshwater withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows. Structures also impact areas beyond their immediate location, affecting the watersheds, air quality, and transportation patterns of communities.

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II. THEORY BUILDING ENVELOPE

A building envelope is the separation between the interior and the exterior environments of a building. It serves as the outer shell to protect the indoor environment as well as to facilitate its climate control. Building envelope design is a specialized area of architectural and engineering practice that draws from all areas of building science and indoor climate control.

Building envelope design includes five major performance objectives:

1. Structural integrity
2. Moisture control
3. Temperature control
4. Control of air pressure boundaries
5. Control of solar radiation including daylight

There are specific issues that need to be addressed when designing a building envelope in a hot-humid country like India. A few tips to bear in mind are:

1. Orientate your building and design your facade to mitigate heat gains. The East and West facades receive the greatest solar radiation, and should be designed to avoid direct sun.

2. Use glazing in an effective and efficient manner for views and day lighting. Vertical glazing from the finished floor level (FFL) up to a height of 750 mm does not serve any day lighting or vision purpose. Glazing between 750 - 2,100 mm from FFL is considered 'vision glazing' but has minimal contribution to day lighting. Glazing above 2,100 mm from FFL is considered daylight glazing, and is most effective in harvesting natural light for internal illumination; however, care should be taken to avoid creating glare or visual discomfort.

3. Where insulation is applied to wall surfaces, the insulation shall be continuous to prevent heat conduction through the gaps.

4. Glass with a lower U-value and Shading Coefficient (SC) reduces solar heat gains and subsequently, cooling loads. Low SC values are most effective at reducing heat gains. These properties need to be balanced with an appropriate Visible Light Transmittance (VLT), which affects day lighting.

5. Consider life span, durability and life cycle-costing when selecting facade materials. An expensive but low-maintenance and durable material may be economical when factored over the building's life.

Allow provision for easy access for maintenance and cleaning especially for curtain wall systems. This helps to ensure that your facade system will continue to perform at an optimal level.

Strategies to address the green building issues associated with building envelope design include:

III. HEAT GAIN AND ENERGY PERFORMANCE

As an environmental filter, the building facade or envelope is often the fi rst line of defense against undesirable external elements. In India, like all climates where cooling is the primary concern, the major issue is avoidance of solar radiation which leads to heat gain. This is quantified through the Envelope Thermal Transfer Value (ETTV) for non-residential buildings & Residential Envelope Thermal Transmittance Value (RETV) for residential buildings:

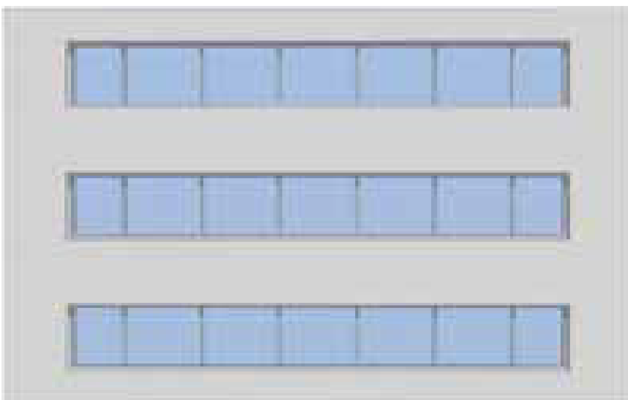
ETTV and RETV estimate heat gain through the building envelope, and is directly related to a building's cooling load. It takes into account the three basic components:

- Heat conduction through opaque walls (U-value).
- Heat conduction through transparent elements, i.e. windows (U-value).
- Solar radiation through transparent elements, i.e. windows (SC value).

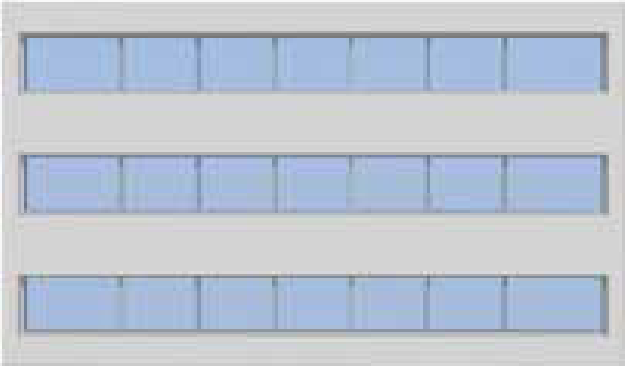
ETTV is tailored to assessing the building envelope for occupancy during the daytime (i.e. non-residential buildings peak occupancy), while RETV is tailored to occupancy in the evening / night (i.e. residential buildings' peak occupancy). For more detailed information refer to the BCA's "Code on Envelope Thermal Performance for Buildings". It is noted that in its current form ETTV / RETV calculations do not consider the effects of shading on opaque walls, only on glazed openings. These three components of heat input are averaged over the whole envelope area of the building. As such, ETTV / RETV represents the thermal performance of the whole envelope. For the purpose of energy conservation, the maximum permissible ETTV has been set at 50 W/m2 and for RETV, The maximum permissible level is set at 25 W/m2. Roof Thermal Transmittance Value (RTTV) operates on the same principle as ETTV, except that it addresses glazing areas and heat transfer through the roof. It is only applicable for skylights, and has the same limit of 50 W/m2

IV. WINDOW-TO-WALL RATIO

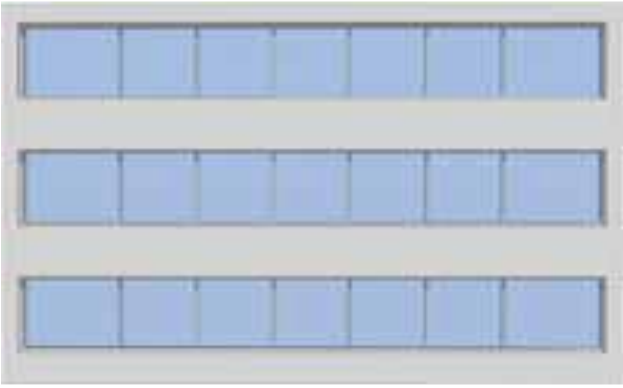
Adjusting the window-to-wall ratio (WWR) of the building envelope affects the amount of heat entering a space.



WINDOW AREA = 40%
WALL AREA = 60%



WINDOW AREA = 50%
WALL AREA = 50%



WINDOW AREA = 60%
WALL AREA = 40%

WINDOW AREA = 70%
WALL AREA = 30%

V. WINDOW-TO-WALL RATIOS

SOME BASIC GUIDELINES ARE:

1. Lower the WWR (i.e. lesser glass and more wall). The lower the WWR, the better the ETTV / RETV. Opaque enclosures generally resist heat transfer better than glass. Reducing window size means more of the outside heat is prevented from being transferred inside because of the solid walls.

2. When the WWR goes beyond 50%, achieving acceptable ETTV / RETV and low heat gains becomes more difficult. A WWR above 50% would normally require high-performance glazing with very low SC, and/or heavy shading in order to comply with ETTV / RETV.

3. Provide glazing where it is effective for views and/or daylight. Avoiding heat gains can be addressed by creative facade design, which should vary as a function of the orientation.

4. Facade orientation should influence the WWR. A North facing facade receives the least solar exposure and should have the largest glazing area.

GLASS PROPERTIES:
Glass properties have significant impact towards reducing the cooling load. Any number of measures can be undertaken to improve glazing performance, each with their own advantages and disadvantages.

Advantages and disadvantages of various measures to improve glazing performance.

	ADVANTAGE	DISADVANTAGE
Use double-glazed units	Lower U-value compared to single glazing Less heat transmission through conduction	Increased cost Greater structural loads
Use glass with lower SC	Less solar heat gain	Usually darker appearance Less opportunity for day lighting
Specify different glass according to function and orientation	Balanced budget – spend on high performance glass where it is most beneficial	More difficult to keep track of various glass types for a single facade or window unit

- Lowering the glazing SC has the greatest impact on a building's ETTV / RETV. Best practice would have SC values in the range of 0.3 to 0.4; glass with this property effectively blocks solar heat gain.

- In selecting glass options, consider balancing U-value and SC value with VLT to allow daylight in while keeping heat out. High-performance glass with VLT values of up to 62% is available in the market or adjustable external shading. Adjustable shading is considered more energy efficient than fixed shading systems. However, adjustable shades often have a premium cost because of its variability, difficulties in developing robust and durable systems, and sometimes operating costs. There may also be a need to increase the facade zone depth which consequently, reduces the interior

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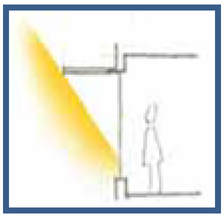
NET FLOOR AREA ON CONSTRAINED SITES

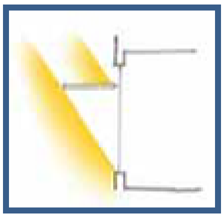
❖ **HORIZONTAL OVERHANG :**

➢ Simple to construct
➢ Effectively blocks high-angle sun
➢ Ineffective in blocking low-angle east and west sun
➢ Requires maintenance as leaves and bird droppings may reside on it



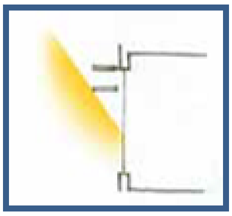
❖ **HORIZONTAL OVERHANG BELOW WINDOW HEAD**

➢ Simple to construct
➢ Blocks high angle sun
➢ Also acts as a light shelf and brings more diffuse light in Ineffective in blocking low-angle east and west sun
➢ Requires maintenance as leaves and birds dropping may reside on it



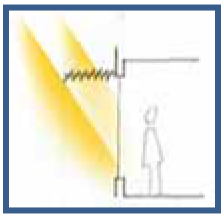
❖ **MULTIPLE SHALLOW OVERHANGS**

➢ Blocks high-angle sun within vision panel
➢ Exposes lower portion of glazing to direct solar radiation
➢ Can also act as a small light shelf
➢ Ineffective in blocking low-angle east and west sun Requires some maintenance



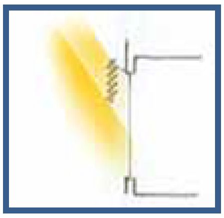
❖ **LOUVERED OVERHANG**

➢ Blocks high-angle sun and diffuses sunlight effectively
➢ More complicated form, hence more maintenance
➢ Ineffective in blocking low-angle east and west sun



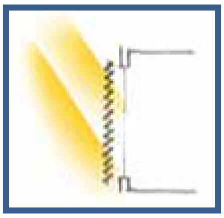
❖ **LOUVERED SCREEN**

➢ Blocks low-angle east and west sun only at high-level
➢ Exposes lower portion of glazing to direct solar radiation
➢ More complicated form, hence more maintenance



FULL HEIGHT LOUVRED SCREEN

➢ Blocks low-angle east and west sun
➢ Diffuses light effectively to create even day lighting
➢ More complicated form, hence more maintenance
➢ Obstructs views to the outdoors



VI. CONCLUSION

❖ **Green buildings save money because they conserve resources and enhance efficiency by:**

❖ Maximizing energy conservation and efficiency by optimizing building orientation and integrating natural daylight and ventilation.

❖ Using natural insulation such as roof gardens;

❖ Using technology such as solar panels, fuel cells, and photovoltaic; and Conserving water and reducing runoff using solar water heating, contour landscaping, and water conserving or water-recycling appliances.

❖ **Green buildings reduce the environmental impact of the building industry by:**

❖ Using materials that are selected based on their life-cycle environmental impacts

❖ Making use of renewable energy resources;

❖ Minimizing the use of mined rare metals and persistent synthetic compounds.

❖ Applying reduces, reuse, and recycle to materials in all phases of construction and demolition, and reducing harmful waste products produced during construction.

GREEN BUILDINGS ENHANCE OCCUPANT SAFETY, HEALTH, AND COMFORT BY:

❖ Reducing or eliminating toxic and harmful materials and finishes;

❖ Applying maintenance and operational practices that reduce or eliminate harmful effects on people and the natural environment; and employing personal, local control over temperature, air flow, and lighting.

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