ANNEXURE 2 of MBBL, 2016

Addendum to Model Building Bye Laws, 2016: Provisions for Cooling Action Plan

1. Introduction

Around 30% of the world's population is currently exposed to life-threatening temperatures for at least 20 days a year and heat waves lead to 12,000 deaths annually across the world. These numbers will increase as the planet warms. Emissions from cooling, if left unchecked, are expected to double by 2030 and triple by 2100, driven by heat waves, population growth and unprecedented urbanization.

Cooling will be one of the top drivers of global power demand over the next three decades. By 2050, space cooling alone will consume as much electricity as India consumes today.

India faces a daunting problem: how to provide access to cooling to its citizens without warming the planet. India has among the most cooling degree days in the world, more than 3,000 per year. A cooling degree day is a measurement designed to quantify the demand for energy needed to cool a building. It is the number of degrees that a day's average temperature is above 18° Celsius, which is the temperature above which buildings need to be cooled. Summers in the northern and western parts of the country are already extremely hot, with average temperatures ranging from 32°C to over 45°C. But the heat is getting worse every year, and these temperatures could rise by up to a further 3° C in many cities by the year 2100, which would likely result in doubling of the number of deaths from exposure to extreme heat waves.

Greening the built environment becomes the necessity as open spaces in the cities are scarce and those that exist are already threatened by the increasing construction activities. A way to balance these conflicting needs is to create a "new layer" of lush and abundant greens. Cities and towns can be enveloped by having more open or green spaces in each structure beyond the prescribed setbacks, such as putting vertical gardens on a blank wall, converting the rooftop to a lush garden, among others.

There is a need to incorporate passive design. Thoughtful building orientation, placement of doors and windows, and harnessing solar and wind energies are few of the passive strategies which can be adopted to manage day lighting and natural ventilation within built buildings. Doing so will reduce energy requirements and promote healthy indoor environments.

Better building designs can reduce or even avoid the energy demand for space cooling. High performance building envelopes can reduce the cooling demand by 30% to 50%.

Climate-adapted building envelopes, exterior colours, windows, natural ventilation, orientation and vegetation offer large possibilities to reduce the energy demand for cooling. Better building designs are highly cost-efficient. The design stage is crucial, when extra effort is minimal. Three steps are needed for cool low-carbon buildings: avoid - shift – improve.

Avoid: High cooling demand through building design adapted to the local climate.
Shift: Remaining cooling to renewables, thermal storage and district cooling.
Improve: Conventional cooling by increasing the efficiency of systems and appliances.

2. Design Features

The following design features shall reduce the energy demand for cooling:

Roof coatings: High-quality white roofs can reflect 80% of the sun's energy compared to black roofs that reflect only 5% to 10%.

Envelopes: High-performance thermal building envelopes (foundations, external walls, roofs and external doors) can reduce the cooling demand by 30% to 50%.

Windows: Low-emissivity glass reflects infrared solar radiation without affecting the entry of visible light and reduces cooling demand by at least 20% compared to conventional glass.

Ventilation: Use of natural ventilation can reduce the overall number of hours of air conditioning needed by as much as 40% while achieving the same indoor comfort level.

Landscape and vegetation: In residential areas, it is assumed that well-designed landscapes could save 25% of the energy used for cooling.

3. Site adaptation

The design takes advantage of the site's surroundings, such as the surrounding vegetation, water bodies and the proximity to other buildings, which can partially or completely shade and cool both the roof and the façades of the new building. In order to reduce the urban heat island effect, green roofs, broad-leaved trees and bushes may be used which provide shade but do not obstruct air circulation.

4. Orientation and shape

Orientation: A building should be oriented from east to west along the main path of the sun, exposing only smaller façades to high solar radiation at low angles.

Shape: In humid climates, larger distances between buildings allow for better air circulation. In arid climates, compact buildings that are close together, expose less façade to the sun and provide shade.

Openings: Most openings (doors, windows, vents) should face north or south to reduce sun exposure. The window positions should allow optimal use of daylight, but with a small surface to avoid solar radiation inside. Horizontal glazing should be avoided.

The window-to-wall ratio should be generally low to minimize internal heat gains while allowing for sufficient natural interior lighting. In hot climates, the total window area must not exceed 20% of the total wall area.

5. Building envelope

Walls: In dry climates, the walls are adequately thick to keep out the heat during the day and release the slowly absorbed heat at night. In humid climates, the walls are light with many openings and vents for ventilation.

Roofs: In dry climates, roofs are adequately thick and insulated. In humid climates, roofs are light and insulated.

Shading: Roof overhangs and exterior shading minimize solar radiation on façades and windows.

Coatings: Bright and reflective coatings on roofs and façades reflect solar radiation and prevent it from entering the interior. Vegetation can protect façades.

Windows: In dry climates, high-performance windows should be used with double glazing and solar film if no external shading is possible, optionally, with natural ventilation during night-time.

In humid climates, louvre windows should be used with insect screens for natural ventilation. Depending on the local security situation, windows might be equipped with installations for ensuring security. The following table highlights efficient design strategies that help reduce a Building's Cooling Needs.

Building Envelope Options to Reduce Cooling Load

Insulation	Increasing thickness and/ or R-value for envelope to Reduce cooling loads up to 8%
Windows	Reducing heat gain by shading: installing double/ triple glazed units having low-E coating can reduce daily cooling demand by 30%. Dynamic glazing technology would further reduce solar heat gains by filtering out infrared radiation while windows continuing to provide natural lighting. Window attachments like blinds, screens and films can also be used to reduce the ingress of solar heat.
Roofing	Installing cool/green rood will reduce solar heat gain due to increased reflection/ evapotranspiration.
Surface orientation	Apposite building orientation and window to wall ratio can refrain direct heat gain in building indoors, thus reducing the cooling demand.

Source: India Cooling Action Plan, 2019: MoEFCC

The future of space cooling in buildings will hugely benefit from a two-pronged approach i.e. Firstly, reducing the need for active cooling in buildings using energy efficiency as a foundational building strategy, and secondly by meeting the reduced cooling demand using efficient cooling technologies.

Passive ventilation and cool-roof technologies facilitate increased thermal comfort. Investments will need to be directed towards clean technologies and low carbon development

If buildings are adapted to the local climate and use passive cooling techniques, they can keep cool naturally. Variations depend on the climate zone, the local building culture and building use. While there are many variations, the following principles apply:

- In humid climates, light- to mid-weight structures and open, spacious layouts allow for constant natural ventilation.
- In dry climates, buildings should be adequately thick to block the heat during the day and naturally cool down at night. Policies should therefore address both better building designs and efficient cooling technologies.
- Policies to curb cooling demand often concentrate on promoting the use of efficient cooling technologies and appliances. This is not enough. There is a need to foster improved building designs which take into account the climatic and cultural context.
- Building design has a major impact on the need for mechanical cooling. Traditional buildings in hot climates often achieve comfortable conditions without electricity. Long roof overhangs, exterior shading elements and green courtyards provide shade to buildings and reduce solar heat gains.
- When designing buildings today, the construction cost and design requirements of clients are often much more important than energy and cooling issues. As a result, achieving thermal comfort is often ignored in the design and left to be solved by mechanical cooling. An improved building design can significantly increase the thermal comfort and reduce or even avoid the energy demand for space cooling.

Following should be considered to conserve the energy:

1. Integrate building design into cooling strategies and Nationally Determines Contribution (NDC) targets;

2. Adopt and enforce ambitious building energy codes for new buildings and renovations;

3. Use financial incentives, information campaigns and capacity-building to promote energy-efficient building design;

4. Develop minimum energy performance standards and labelling for appliances;

5. Make low-income housing energy-efficient to ensure ‘Cooling for all’ and reduce energy poverty.

6. Certification

While applying for occupancy-cum-completion certificate, an undertaking needs to be submitted by an architect that the completed building has adopted all the aspects of cooling covered in this chapter.

NOTE:

Building envelope consists of walls, roof, and fenestration (openings including windows, doors, vents, etc.). Design of building envelope influences heat gain/loss, natural ventilation, and daylighting, which, in turn, determines indoor temperatures, thermal comfort, and sensible cooling/heating demand. Bureau of Energy Efficiency has prepared and issued following two documents for building envelopes design:

1. ***Energy Conservation Building Code (ECBC) 2017:*** The purpose of the Energy Conservation Building Code (Code) is to provide minimum requirements for the energy-efficient building design and construction. The Code also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements. Buildings consume significant proportion of our energy resources and the ECBC is an essential regulatory tool to curb their energy footprint. Passive designs strategies like daylight and shading are mandatory in ECBC 2017. Objective is to encourage design with passive strategies to be the norm for buildings in India. Passive design strategies are one of the most effective methods to ensure that building designs and technologies are sensitive to the surroundings.

2. ***Eco-Niwas Samhita 2018 [Energy Conservation Building Code – Residential (ECBC-R)] (Part I: Building Envelope):*** It has been prepared to set minimum building envelope performance standards to limit heat gains (for cooling dominated climates) and to limit heat loss (for heating dominated climates), as well as for ensuring adequate natural ventilation and daylighting potential. The code provides design flexibility to innovate and vary important envelope components such as wall type, window size, type of glazing, and external shading to windows to meet the compliance. Building envelope has the highest impact on thermal comfort, and consequently on the energy use in residential buildings. The envelope is also a permanent component of the building with the longest life cycle. An early introduction of this code would improve the design and construction of new residential building stock being built currently and in the near future, thus significantly curtailing the anticipated energy demand for comfort cooling in times to come. This critical investment in envelope design and construction made today will reap benefits of reduced GHG emissions for the lifetime of the buildings.

References

1. Programme For Energy Efficiency in Buildings Working Paper (August 2020) namely 'Better Design for Cool Buildings- How Improved Building Design can Reduce the Massive Need for Space Cooling in Hot Climates'.
2. India Cooling Action Plan, 2019 published by Ministry of Environment, Forest and Climate Change. (Link at): http://ozonecell.nic.in/wp-content/uploads/2019/03/INDIA-COOLING-ACTION-PLAN-e-circulation-version080319.pdf
3. Ahmedabad Heat Action Plan, 2018

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