2. Prioritise comfort for building users

2.1 Ensure consistent thermal comfort, with awareness of varying occupant needs, to enhance wellbeing

State of health

Thermal comfort is a primary indicator of human wellbeing, and the built environment's provision of shelter is a fundamental element of its very purpose. Design at both community and building level can substantially impact both the feasibility and energy requirements for achieving thermal comfort in a building.

Building design and operation relating to thermal comfort are influenced by a broad spectrum of environmental and socio-economic factors, which can both protect and heighten risks to the health of the occupant. Furthermore, population susceptibility to climate change is increasing, heightening exposure to both dangerous heat and cold temperature events across the world. Globally, extreme temperature events are observed to be increasing in their frequency, duration, and magnitude and this trend is predicted to continue[1].

Between 2000 and 2016, the number of people exposed to heat waves increased by around 125 million. In 2015 alone, 175 million additional people were exposed to heat waves compared to average years[2], causing heat illness (dehydration, heat cramps, heat stroke), and accelerated death from respiratory disease, cardiovascular disease and other chronic diseases. Additionally, continual exposure to cold temperatures (particularly in the home) increases the risks of cardiovascular, respiratory and rheumatoid diseases and may also negatively impact mental health. Cold homes are a significant contributor to the level of excess winter deaths in temperature climates[3].

Outside weather extremes, thermal comfort can affect people's mood, performance and productivity, with research showing a correlation between perceived comfort and productivity[4]. This is particularly true of overheating, creating the necessity for mechanical cooling interventions, can lead to an increase in carbon emissions from energy expenditure. Humidity control also affects comfort and the spread of disease, which should be studied from a local climatic perspective to strike a balance of health and comfort.

Refrigerant management is a linked key issue, as cooling technologies utilised for thermal comfort and healthcare purposes across the world are emitting large quantities of HFC, a potent greenhouse gas and climate change forcer[5] (see Principle 6.1 for more information).

Outcomes

- Design for user control of heating, cooling and humidity control in space to ensure optimal individual comfort in operational buildings, while maintaining energy efficiency with broad consideration of the environment. Sustainable master-planning mitigates community level thermal comfort issues, such as the (Urban) Heat Island effect.

Strategies across the lifecycle

Design:

- Use of master-planning principles in new or retrofitted buildings on community scale, offering protection from environmental elements, eg. neighbouring buildings shading or spacing to control solar or convective gain and heat loss from wind and design to prevent Heat Islands

- Air tightness and ventilation: an airtight envelope, together with natural or mechanical ventilation, can control the indoor thermal environment by managing the air exchanges with the outside
- Passive heating and cooling (thermal massing): the materials used to construct the building have an impact on how quickly changes in weather conditions are felt. Materials with a higher thermal mass will take longer to change to ambient temperature conditions, and therefore can act as a natural heat store during daytime with slow release at night
- Design to utilise beneficial solar gain: through its overall shape, orientation, number and size of windows and the ability of surfaces to reflect heat, the building envelope can control how much heat from the sun (solar gain) is allowed to enter into the building
- Insulation: Insulating the building envelope and using thermally efficient windows reduces heat loss in winter and conduction heat gains in summer
- Retain existing trees*:* A tree is a natural air conditioner and can help to reduce urban heat island effect. The evaporation from a single tree can produce the cooling effect of ten room-size, residential air conditioners operating 20 hours a day. Tree windbreaks can reduce residential heating costs 10-15%; while shading and evaporative cooling from trees can cut residential air-conditioning costs 20-50%[6]
- Incorporation of Passive House Design Guidelines[7] to achieve thermal protection whilst maximising energy efficiency opportunity
- Adoption or influence of traditional, vernacular design architectural strategies

Operation:

- User policy to allow flexibility for building user to meet individual's varying comfort needs
- Aftercare initiatives to ensure occupant awareness of building management for comfort

Benchmarks

- ASHRAE Standard 55-2017 notes that for thermal comfort purposes, indoor temperatures could range from between approximately 67 and 82 °F, or 19 and 28°C[8]
- ASHRAE Standard 62.1-2016 recommends that relative humidity in occupied spaces be controlled to less than 65% to reduce the likelihood of conditions that can lead to microbial growth
    - CIBSE suggests for offices that the temperature ranges for comfort should be graduated depending on geography and culture. For air-conditioned buildings this should be 21-23ºC in winter and 22-24ºC in summer[9].
    - Higher temperatures are acceptable for buildings in tropical climates, for example the Hong Kong government recommend 25.5°C as optimum indoor temperature for air-conditioned spaces, striking a balance of comfort and energy conservation[10].
- Passive House Guidelines. https://passivehouse-international.org/index.php?page_id=80
- The WHO 'Housing and Health Guidelines' (2018) recommendation indoor housing temperatures of 18°C (and over) for countries with temperate or cold climates to protect occupant health at cold periods
- Legislation and guidance around temperature depends on building use. UK law states work environments should be at least 16°C in more sedentary workplaces, and above 13°C where work requires physical effort[11].

More information

The list below is a non-exhaustive list of further resources, put together by inputs received by WorldGBC global network members.

- ASHRAE Standard 55-2017 Thermal environmental conditions for human occupancy. Available at: https://www.ashrae.org/technical-resources/bookstore/standard-55-thermal-environmental-conditions-for-human-occupancy

- ASHRAE. 1999. 'An investigation into thermal comfort at high humidities' https://www.researchgate.net/publication/245347428_An_investigation_of_thermal_comfort_at_high_humidities
- Beam Plus New Buildings V2.0 'Health and Wellbeing, Sustainable Site': https://www.hkgbc.org.hk/eng/beam-plus/file/BEAMPlus_New_Buildings_v2_0.pdf
- Beam Plus Neighbourhood V1.0 'Outdoor Environmental Quality': https://www.beamsociety.org.hk/files/Manual/BEAMPlusNDManualWithCorrigendumNo1.pdf
- Bogdanovic, V et al. 2018. Improving thermal stability and reduction of energy consumption by implementing Trombe Wall construction in the process of building design - The Serbia Region. Thermal Science: https://www.researchgate.net/publication/325468453_Improving_thermal_stability_and_reduction_of_energy_consumption_by_implementing_Trombe_Wall_construction_in_the_process_of_building_design_-_The_Serbia_Region
- BREEAM International New Construction Standard 'Hea 04 Thermal comfort': https://www.breeam.com/discover/technical-standards/
- BREEAM International In-Use Standard 'Hea 07 User comfort control', 'Hea 14 Thermal comfort': https://www.breeam.com/discover/technical-standards/
- CABR & CABR & CSUS. Green Building Research Centre, Healthy Building Evaluation Standard 'Thermal Comfort' Clauses http://healthybuilding.gbonline.org/, plus Yu Wei, Zhao Xuyuan, Li Baizhan. Interpretation of the Comfort Section of "Healthy Building Evaluation Standard"-Thermal Comfort. Construction Technology, 2018, 49(05): 489-492
- DGNB ' Liveable and Fit for the Future' https://www.dgnb.de/en/council/publications/index.php
- DGNB ' The cost trap of refrigerants' https://www.dgnb.de/en/council/publications/index.php
- Emirates Green Building Council: 'Emirates Coalition for Green Schools' https://emiratesgbc.org/technical-programs/green-schools/
- Green Building Council of Australia Green Star - Design & As Built 'Indoor Environment Quality: https://new.gbca.org.au/green-star/rating-system/design-and-built/
- Green Building Council of Australia (GBCA) 2018 'Building with nature, Prioritising ecology and biodiversity for better buildings and cities': https://new.gbca.org.au/green-star/green-star-strategy/building-nature/#buildingwithnature
- IGBC Green Interiors Rating Tool: 'Thermal Comfort' https://igbc.in/igbc/redirectHtml.htm?redVal=showgreeninteriorsnosign#GreenHomes
- IGBC Health and Wellbeing Rating Tool: 'Thermal Comfort' https://igbc.in/igbc/redirectHtml.htm?redVal=showHealthWellBiengnosign#Resources
- Izael Da Silva; Edward Baleke Ssekulima 'Energy Efficient Building Envelope Designs for Institutional Buildings in East Africa': https://su-plus.strathmore.edu/bitstream/handle/11071/3489/Energy%20Efficient%20Building%20Envelope%20Designs%20For%20Institutional%20Buildings%20in%20East%20Africa.pdf?sequence=1&isAllowed=y
- Jordan GBC. 'Your guide to building envelope retrofits for optimising energy efficiency and thermal comfort in Jordan' https://drive.google.com/file/d/1iUk8Dd59jIt27ucudGbk7mXgth2yKrxk/view (Link to be updated)
- Mujan, I. 2019. Influence of indoor environmental quality on human health and productivity - A review, Journal of Cleaner Production: https://www.sciencedirect.com/science/article/abs/pii/S0959652619303348?via%3Dihub
- ONNCCE. 2018 'Environmental Quality - NMX-C-7730-ONNCCE-2018' https://www.onncce.org.mx/es/?option=com_merchant&view=category&cid=46
- Passive House Guidelines. https://passivehouse-international.org/index.php?page_id=80
- Ricardo Forgiarini Ruppa, Natalia Giraldo Vásquez, Roberto Lamberts, 2015 'A review of human thermal comfort in the built environment' https://viterbik12.usc.edu/wp-content/uploads/2017/06/2015-Energy-and-Buildings-Rupp2c-Va%CC%81squez2c-Lamberts-A-review-of-human-thermal-comfort-in-the-built-environment.pdf
- Saint-Gobain. Multi-Comfort principles, Thermal: https://multicomfort.saint-gobain.com/comforts-and-solutions/thermal-comfort.

- Seppänen, O, Fisk, W & Lei, Q, 2006. Effect of temperature on task performance in office environment. Lawrence Berkeley National Laboratory, p.11.
- Shaw Contract. Sound Advisor Tool. https://shawcontract.soundadvisor.com/
- Thermal and Acoustic Comfort in Buildings - S. Monteiro da Silva. M. Guedes de Almeida (https://pdfs.semanticscholar.org/f7ba/b394b6b07a9165e2b3685a339425bb7584a1.pdf)
- World Health Organization. Housing and Health Guidelines: https://www.who.int/publications/i/item/who-housing-and-health-guidelines
- Wyon, D P & Wargocki, P, 2013. How indoor environment affects performance. ASHRAE Journal, 55(3), pp.46–52.

2.2 Maintain exemplary lighting for occupant wellbeing, with natural and energy-efficient solutions prioritised

State of health

Natural light regulates our body's circadian rhythms, impacting sleep quality and therefore health overall. This is often disrupted by technology, noise and light pollution, facets of a typical modern, urban lifestyle.

Within a building, exposure to artificial lighting can disrupt circadian rhythms, making it more difficult to be alert and to maintain healthy sleep patterns. Inadequate lighting can create eye strain and in doing so cause headaches. Studies have shown that exposure to natural light during the working day leads to 46 minutes more sleep each night[12]. Conversely, workers in windowless environments report poorer sleep quality[13], which has consequential negative effects on worker productivity.

Exposure to natural light offers additional benefits within a built environment. Direct sunlight can provide beneficial solar gain, reducing heating requirements in temperate climates, and allowing daylight into buildings can assist in the prevention of damp, mould and bacteria growth, lowering the risk of asthma and other respiratory diseases.[14] The risk of overheating from solar gain must be managed to maintain thermal comfort.

Outcomes

- Provision of adequate artificial lighting that is flicker free, meets minimum requirements for lighting colour, have little glare and ideally, have localised lighting controls and is appropriate for space use. All lighting should be energy efficient.

Strategies across the lifecycle

Design:

- Maximise use of natural light, using screens and blinds to minimise glare where necessary
- Avoiding the specification of glossy finishes and surfaces.
- Specifying light-coloured opaque shading devices (e.g. blinds) to prevent direct sunlight but allow daylight penetration.

Construction:

- Require luminaires are installed at a height of 5 m (16 ft) or lower meet UGR of 17 or lower, or, luminaires installed at a height greater than 5 m (16 ft) meet UGR of 20 or lower.

Operation:

- Developing a glare control strategy in tandem with any lighting strategy; ensuring glare reduction measures does not increase energy used for lighting, by maximising the potential for daylight in all weather and ensuring that the location of shading does not conflict with the operation of lighting control.
- Considering manually or automatically operated blinds to minimise glare.
- Internal layout coordination for comfort, eg. location of computer screens with lighting and window locations to avoid glare.

Benchmarks

- Ensure annual sunlight exposure of ASE1000,250 is achieved for no more than 10% of regularly occupied space.
- CIBSE provides international guidance on recommended indoor lighting levels (lux) based on space type[15]

- Minimum Colour Rendering Index (CIR) of 80
- Saint-Gobain ‘Multi-Comfort’ principles: Visual Comfort

More information

- BCO Wellness Matters. ‘Roadmap: See’ http://www.bco.org.uk/HealthWellbeing/WellnessMatters.aspx
- Beam Plus New Buildings V2.0 ‘Health and Wellbeing, Sustainable Site, Integrated Design and Construction Management: https://www.hkgbc.org.hk/eng/beam-plus/file/BEAMPlus_New_Buildings_v2_0.pdf
- BREEAM International New Construction Standard ‘Hea 01 Visual comfort’: https://www.breeam.com/discover/technical-standards/
- BREEAM International In-Use Standard ‘Hea 01 Daylighting’… [and all credits until] ‘Hea 05 Minimising flicker from lighting systems’: https://www.breeam.com/discover/technical-standards/
- CABR & CABR & CSUS. Green Building Research Centre, Healthy Building Evaluation Standard ‘Light Environment’ Clauses http://healthybuilding.gbonline.org/, plus Zhao Jianping, Gao Chunchun. The chapter of the light environment interpretation of "Healthy Building Evaluation Standard". Architecture Technology, 2018, 49(06): 652-654
- DGNB ‘ Liveable and Fit for the Future’ https://www.dgnb.de/en/council/publications/index.php
- Emirates Green Building Council: ‘Emirates Coalition for Green Schools’ https://emiratesgbc.org/technical-programs/green-schools/
- Illuminating Engineering Society (IES) The Lighting Handbook 10th Edition, New York (Chapter 33) available at: https://www.ies.org/product-category/lighting-handbooks/
- Green Building Council of Australia Green Star - Design & As Built ‘Indoor Environment Quality: https://new.gbca.org.au/green-star/rating-system/design-and-built/
- Green Building Council of Australia (GBCA) 2018 ‘Building with nature, Prioritising ecology and biodiversity for better buildings and cities’: https://new.gbca.org.au/green-star/green-star-strategy/building-nature/#buildingwithnature
- IGBC Green Interiors Rating Tool: ‘Daylighting’ and ‘Energy Efficiency (Interior Lighting)’ https://igbc.in/igbc/redirectHtml.htm?redVal=showgreeninteriorsnosign#GreenHomes
- IGBC Health and Wellbeing Rating Tool: ‘Visual Comfort’ https://igbc.in/igbc/redirectHtml.htm?redVal=showHealthWellBiengnosign#ResourcesNational standards e.g, AS/NZ 1680.1:2006 Interior and workplace lighting - Part 1: General principles and recommendations.
- Mohd Ariffin, Noor Aziah & Ibrahim, Illyani. 2018. Energy efficiency through lighting systems in institutional buildings in Nigeria. https://www.researchgate.net/publication/327741145_Energy_efficiency_through_lighting_systems_in_institutional_buildings_in_nigeria
- Mujan, I. 2019. Influence of indoor environmental quality on human health and productivity - A review, Journal of Cleaner Production: https://www.sciencedirect.com/science/article/abs/pii/S0959652619303348?via%3Dihub
- Ontario Ministry of Labour. Computer Ergonomics: Workstation Layout and Lighting. Toronto: Ontario Ministry of Labour; September 2004. https://www.lakeheadu.ca/sites/default/files/uploads/2215/Policies-procedures/computer-station.pdf
- Saint-Gobain ‘Multi-Comfort’ principles: Visual Comfort - https://multicomfort.saint-gobain.com/comforts-and-solutions/visual-comfort
- S Batchelor, N Scott, J McAllister. 2017 ‘Guidelines for clean energy, Sub Saharan Africa’: https://africancityenergy.org/uploads/resource_101.pdf
- Smart Cities World Whitepaper: ‘Buildings are getting smarter, are they also getting healthier?’ https://www.smartcitiesworld.net/whitepapers/buildings-are-getting-smarter-
- Urban Land Institute. 2015. ‘Building Healthy Places Toolkit’ https://bhptoolkit.uli.org/
- WELL Building Standard ‘Light’ https://standard.wellcertified.com/light

2.3 Maintain acoustic comfort

State of health

Prolonged exposure to noise can lead to serious health effects, including cardiovascular diseases[16], elevated blood pressure, cognitive impairment and mental health problems (including stress and burnout) as well as sleep disturbances and a feeling of discomfort affecting general wellbeing[17]. Over time these effects have a detrimental impact on wellbeing and perceived quality of life. The World Health Organisation has reported noise is the second largest environmental cause of health problems, following the impact of air quality (particulate matter).[18]

The European Union has reported that sleepers exposed to night noise levels above 40dB on average throughout the year can suffer sleep disturbance, while long-term average exposure above 55dB can trigger elevated blood pressure and lead to ischaemic heart disease[19]. Environmental noise causes approximately 16,600 cases of premature death in Europe each year, with almost 32 million adults estimated to suffer annoyance and over 13 million adults estimated to suffer sleep disturbance[20].

In the UK, a study estimated that 54% of the population was exposed to noise pollution above recommended levels of 55 decibels[21]. Exposure to air traffic noise has also been linked to a negative impact on student performance in educational institutions, recording a significant relationship to poor reading and mathematical performance[22].

Outcomes

- Mitigation of steady state noise exposure: this is defined as noise, the level of which does not change by more than 5dB at a given place and during a given time period, such the sound of a waterfall. Continuous background sound in offices is mostly generated by heating, ventilation, and air conditioning (HVAC) equipment. External noise should be mitigated with building features as far as possible, as openable windows should be optimized for ventilation control and therefore not be relied upon as acoustic control.

Strategies across the lifecycle

Design:

- Control reverberation noise: exchanging natural sound absorbing products such as carpets and thick curtains with hard flooring and modern blinds can have the effect of amplifying noise. To control reverberation time, acoustic absorption is used, usually in forms of either fibrous materials or open-celled foam.[23]
    - Acoustic and thermal comfort strategies can often be complementary: a well-insulated building can assist in shielding the occupant from outdoor noise sources

Construction:

- Ensure discontinuous construction in residential settings to limit acoustic impact on local people

Operation:

- Office equipment generating noise levels above the background should be located away from primary work areas or should be surrounded by acoustically isolating panels.
- Noise induced by mechanical equipment should be controlled through vibration isolation devices, appropriate placement of equipment and noise attenuators in ducts.
- Sound absorbing materials are used to help control reflected sound energy and echoes.

- Buildings located near airports, highways, rail corridors or other sources of significant environmental noise levels must have exterior wall and window assemblies controlling noise intrusions.[24]
- Electronic background noise or sound masking can be deployed as specific design consideration[25]. Soundscapes, such as soft music, flowing water or natural sounds can provide a sense of happiness and enjoyment.

Benchmarks

- The World Health Organization make the following recommendations within 'Environmental Noise Guidelines for the European Union':
  - Road traffic noise: reduce noise levels produced by road traffic below 53 decibels (dB) L_{den} (day evening night level)
  - Railway noise: reduce noise levels produced by railway traffic below 54 dB L_{den} in daytime, and below 44 dB Lnight as night noise exposure levels.
  - Aircraft noise: reduce average noise levels produced by aircraft below 45 dB Lden during daytime, and below 40 dB Lnight as night-time aircraft noise exposureLeisure noise: reduce yearly average from all leisure noise sources combined to 70 dB LAeq,24h.
- Saint-Gobain 'Multi-Comfort' principles: Acoustic Comfort

More information

- BCO Wellness Matters. 'Roadmap: Hear' http://www.bco.org.uk/HealthWellbeing/WellnessMatters.aspx
- Beam Plus New Buildings V2.0 'Health and Wellbeing, Sustainable Site, Integrated Design and Construction Management: https://www.hkgbc.org.hk/eng/beam-plus/file/BEAMPlus_New_Buildings_v2_0.pdf
- BREEAM International New Construction Standard 'Hea 05 Acoustic performance': https://www.breeam.com/discover/technical-standards/
- BREEAM International In-Use Standard 'Hea 17 Acoustic conditions': https://www.breeam.com/discover/technical-standards/
- CABR & CSUS. Green Building Research Centre, Healthy Building Evaluation Standard 'Comfort' Chapter http://healthybuilding.gbonline.org/, plus Yan Guojun, Wu Weibin, Zhao Qiyuan, Jiang Tao. Interpretation of the Comfort Chapter of the Evaluation Standard for Healthy Buildings-Acoustic Comfort. Construction Technology, 2018, 49(05): 493-495
- DGNB ' Liveable and Fit for the Future' https://www.dgnb.de/en/council/publications/index.php
- International Organization for Standardization (2014) ISO 16283-1:2014 Acoustics — Field measurement of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation, available at https://www.iso.org/standard/55997.html
- Emirates Green Building Council: 'Emirates Coalition for Green Schools' https://emiratesgbc.org/technical-programs/green-schools/
- Green Building Council of Australia (GBCA) 2018 'Building with nature, Prioritising ecology and biodiversity for better buildings and cities': https://new.gbca.org.au/green-star/green-star-strategy/building-nature/#buildingwithnature
- Green Building Council of Australia Green Star - Design & As Built 'Indoor Environment Quality: https://new.gbca.org.au/green-star/rating-system/design-and-built/
- GSA. 2011 'Sound Matters: How To Achieve Acoustic Comfort In The Contemporary Office' https://www.wbdg.org/ffc/gsa/criteria/sound-matters-how-achieve-acoustic-comfort-contemporary-office
- IGBC Green Interiors Rating Tool: 'Material Acoustic Performance' https://igbc.in/igbc/redirectHtml.htm?redVal=showgreeninteriorsnosign#GreenHomes
- IGBC Health and Wellbeing Rating Tool: 'Acoustic Comfort' https://igbc.in/igbc/redirectHtml.htm?redVal=showHealthWellBiengnosign#Resources
- ISO 140-4:1998 Acoustics – Measurement of sound insulation of buildings and of building elements – Part 4: Field measurements of airborne sound insulation between rooms.

- Mujan, I. 2019. Influence of indoor environmental quality on human health and productivity - A review, Journal of Cleaner Production: https://www.sciencedirect.com/science/article/abs/pii/S0959652619303348?via%3Dihub
- Niklas Moeller. Achieving Acoustic Comfort in Green Buildings (https://www.constructormagazine.com/achieving-acoustic-comfort-green-buildings/)
- Saint-Gobain 'Multi-Comfort' principles: Acoustic Comfort - https://multicomfort.saint-gobain.com/comforts-and-solutions/acoustic-comfort
- Thermal and Acoustic Comfort in Buildings - S. Monteiro da Silva. M. Guedes de Almeida (https://pdfs.semanticscholar.org/f7ba/b394b6b07a9165e2b3685a339425bb7584a1.pdf)
- Urban Land Institute. 2015. 'Building Healthy Places Toolkit' https://bhptoolkit.uli.org/
- U.S. General Services Administration (GSA) – *3.4 Special Design Considerations*, available at: https://www.gsa.gov/node/84139
- World Health Organization Environmental Noise Guidelines for the European Union - http://www.euro.World Health Organization.int/__data/assets/pdf_file/0009/383922/noise-guidelines-exec-sum-eng.pdf?ua=1
- World Health Organization night noise guidelines for Europe available at: http://www.euro.World Health Organization.int/en/health-topics/environment-and-health/noise/policy/World Health Organization-night-noise-guidelines-for-europe

2.4 Consider wider comfort indicators to support occupant wellbeing, including olfactory, ergonomic and visual comfort

State of health

The built environment can be directly responsible for a range of human health and comfort influencers that are outside 'traditional' building design conscience. Wider comfort indicators include olfactory, ergonomic and visual comfort. Olfactory discomfort from unpleasant odours can trigger eye, nose and throat irritation, nausea and headaches. Repetitive tasks and visual discomfort can strain muscles and ligaments, leading to decreased occupant health and wellbeing.

Wider comfort indicators can also extend to consider beyond the 'traditional' scope of design for health, wellbeing and quality of life; "*Comfort alone is not enough. We need to continue to develop a deeper understanding about the effects of the environment on the health and wellbeing of people and widen our scope of design to produce more flourishing, stimulating, creative and productive places for people*…" (BCO, 2018). Design and operational factors that can produce the additional 'flourish' factor may include interior design and aesthetics, colour, character, layout and functionality, space, access to views, nature and greenery[26].

Outcomes

A built environment that incorporates strategies to improve occupant visual, olfactory and ergonomic comfort, whilst actively mitigating wider wellbeing risk to people. Visual comfort and interior design for aesthetics should be designed in accordance with guidance on hazardous chemicals in Principle 6.4.

Strategies across the lifecycle

Design:

- Design of interiors and outdoors for visual stimulation, aesthetic pleasure and comfort
- Olfactory: Limiting the spread of odours by separating source (sources may include restrooms, kitchens and cleaning products) using pressurisation, self-closing doors and design strategies (such as hallways)

Operation:

- Ergonomics: furniture interventions can include adjustable workspaces, sit to stand desks, adjustable chairs.

Benchmarks

- BCO Wellness Matters. Roadmap: 'Sense' and 'Inside' sections http://www.bco.org.uk/HealthWellbeing/WellnessMatters.aspx
- Clements-Croome 2018. 'The Flourish Framework'
- ISO 21542:2011 - Accessibility and Usability of the Built Environment
- Ergonomics: Ergonomics - BIFMA G1 standard and guidelines

More Information

- BCO Wellness Matters. http://www.bco.org.uk/HealthWellbeing/WellnessMatters.aspx
- DGNB ' Liveable and Fit for the Future' https://www.dgnb.de/en/council/publications/index.php
- Wellbeing in Interiors – Philosophy, Design & Value in Practice"
- Emirates Green Building Council: 'Emirates Coalition for Green Schools' https://emiratesgbc.org/technical-programs/green-schools/
- Green Building Council of Australia (GBCA) 2018 'Building with nature, Prioritising ecology and biodiversity for better buildings and cities': https://new.gbca.org.au/green-star/green-star-strategy/building-nature/#buildingwithnature

- Green Building Council of Australia Green Star - Design & As Built ‘Indoor Environment Quality: https://new.gbca.org.au/green-star/rating-system/design-and-built/
- IGBC Green Interiors Rating Tool: ‘Ergonomic Design’ https://igbc.in/igbc/redirectHtml.htm?redVal=showgreeninteriorsnosign#GreenHomes
- IGBC Health and Wellbeing Rating Tool: ‘Ergonomics, Olfactory and Visual Comfort’ sections https://igbc.in/igbc/redirectHtml.htm?redVal=showHealthWellBiengnosign#Resources

2.5 Ensure inclusive design of the built environment

State of health

"Inclusive Design is the design of an environment so that it can be accessed and used by as many people as possible, regardless of age, gender and disability"; The Inclusive Design Hub.[27]

Recent World Health Organization publications estimate that 15% of people worldwide have a disability[28], of whom 2-4% experience significant difficulties in functioning. Blindness and vision impairment are particularly prevalent, estimated to affect at least 2.2 billion people around the world[29]. This proportion of disability in the global population is increasing, due partially to improvements in measurement capabilities to assess disabilities, but also the ageing global population. The global population aged 60 years or over has doubled since 1980[30]. The number of older persons is expected to double again by 2050, when it is projected to reach nearly 2.1 billion.

Outcomes

Inclusive design must keep the diversity and uniqueness of each individual building occupant in mind, considering all people utilising a built environment, including those with mental and physical disabilities as well as vulnerable and ageing populations. An environment that is designed inclusively must apply to buildings, their surrounding open spaces, and local urban infrastructure and services.

Strategies across the lifecycle

Design:

- Universal design for inclusion, conscious of diversity and accessibility, increases usability, safety, health and social participation[31].
    - Follow principles of inclusive design for the built environment[32] published by the Commission for Architecture and the Built Environment (see More Information)
- Design strategies for dedicated populations, ranging from accessibility measures to enhanced social engagement interventions for ageing groups.
    - Age-friendly environments should include particular measures to increase safety and security of older people and ensure continued engagement with community.
    - Design to cater for partially sighted people should ensure clear differences between colour of pillars and floors, between steps and change in levels.
- Built environment professionals should involve potential users at all stages of the design process; from the design brief and detailed design through to construction and completion.
    - Focus on identification of barriers to inclusion as early as possible within the design process so that good design can overcome them.

Operation:

- Creating a culture of accessibility: enabling environments can be physical, social and attitudinal. Accessible environments are particularly relevant for people with different levels of abilities while also benefiting the broader population.
- Supportive company policies to support diversity in the workforce, including flexible scheduling, child and elder care support, diversity and inclusion and wage equity policies, paid parental leave and civic engagement and gathering input and feedback from employees.

Benchmarks

- ISO 21542:2011 - Building Construction - Accessibility and Usability of the Built Environment Available at: https://www.iso.org/standard/50498.html

More information

- Beam Plus New Buildings V2.0 'Health and Wellbeing': https://www.hkgbc.org.hk/eng/beam-plus/file/BEAMPlus_New_Buildings_v2_0.pdf
- Beam Plus Neighbourhood V1.0 'Outdoor Environmental Quality': https://www.beamsociety.org.hk/files/Manual/BEAMPlusNDManualWithCorrigendumNo1.pdf "Building for Everyone – A Universal Design Approach"; http://universaldesign.ie/Built-Environment/
- BREEAM International New Construction Standard 'Hea 06 Accessibility': https://www.breeam.com/discover/technical-standards/
- BREEAM International In-Use Standard 'Hea 12 Inclusive design': https://www.breeam.com/discover/technical-standards/
- Centre for Excellence in Universal Design. What is Universal Design. http://universaldesign.ie/What-is-Universal-Design/. Accessed February 12, 2018.
- Commission for Architecture and the Built Environment (CABE) 'The Principles of Inclusive Design' https://www.designcouncil.org.uk/sites/default/files/asset/document/the-principles-of-inclusive-design.pdf
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