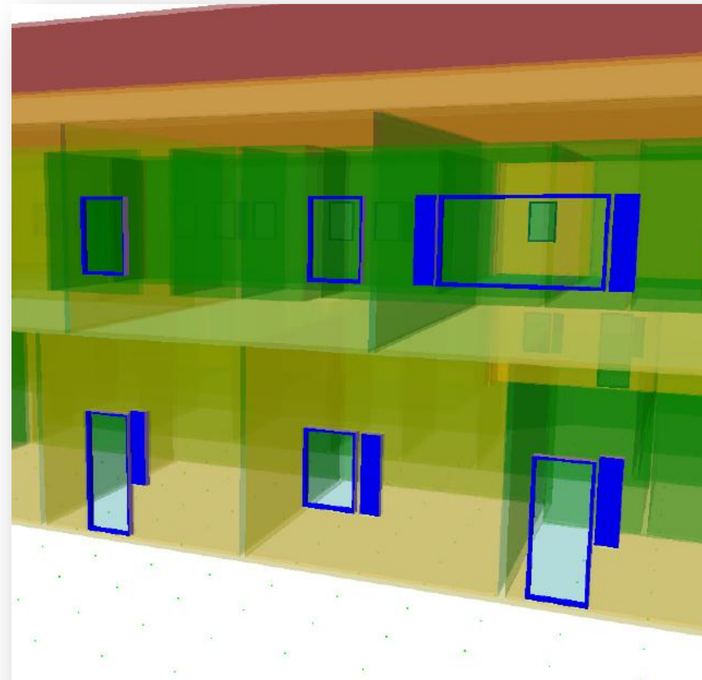
CIBSE Application Manual AM11 'Building Performance Modelling'

Chapter 5: Thermal Environment Modelling

Contents

- Which thermal comfort standard to choose?
- When to start modelling during design?
- Which approach to use?
- Simplified techniques
- Dynamic thermal environment modelling
- CFD for the indoor thermal environment



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Background: process overview

- Chapter focus is on dynamic thermal modelling
- Agree thermal environment criteria with client early on
- Aim to maximise the 'mid-season' periods (i.e. when active cooling or heating not needed)
- See AM11 Section 5.1

1. Agree with client indoor thermal environment conditions to be achieved:
- For heating season, mid-season, and cooling season
- Climate change to be addressed?
- Ventilation strategies for heating, mid- , or cooling season conditions may differ

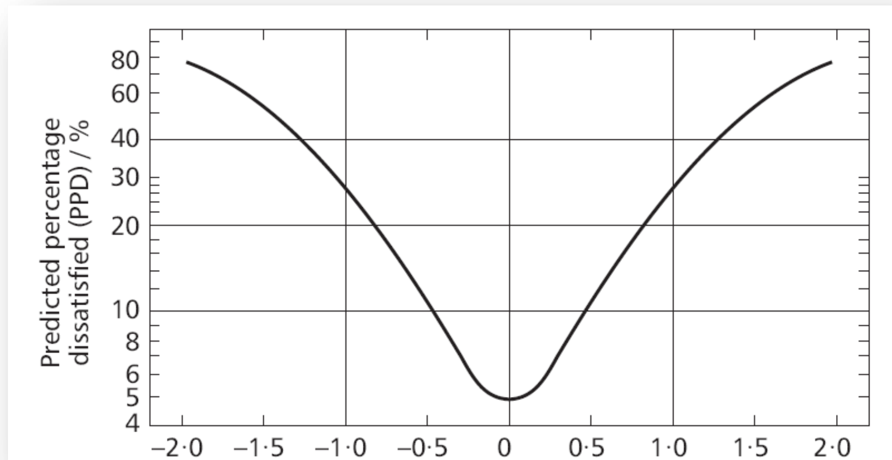
2. Calculate indoor thermal environment in mid-season conditions
- No overheating or under-heating should arise during mid-season conditions

3(a). Calculate indoor thermal environment in 'heating season' conditions

3(b). Calculate indoor thermal environment in 'cooling season' conditions

Which thermal comfort standard to choose?

- Air or operative temperature 'out-of-range' standards (e.g. CIBSE Guide A)
- Heat balance standards (e.g. BS EN ISO 7730)
- Adaptive thermal comfort standards (e.g. BS EN 15251)
- Heat balance versus adaptive: often lead to fundamentally different design approaches and the implications for facilities management and occupant behaviour differ between them
- See AM11 Section 5.2



When to start modelling during design and which approach to use?

- RIBA Stage 2 – Concept design
- RIBA Stage 3 – Design development
- RIBA Stage 4 – Technical design
- Later RIBA work stages

- See AM11 Section 5.3

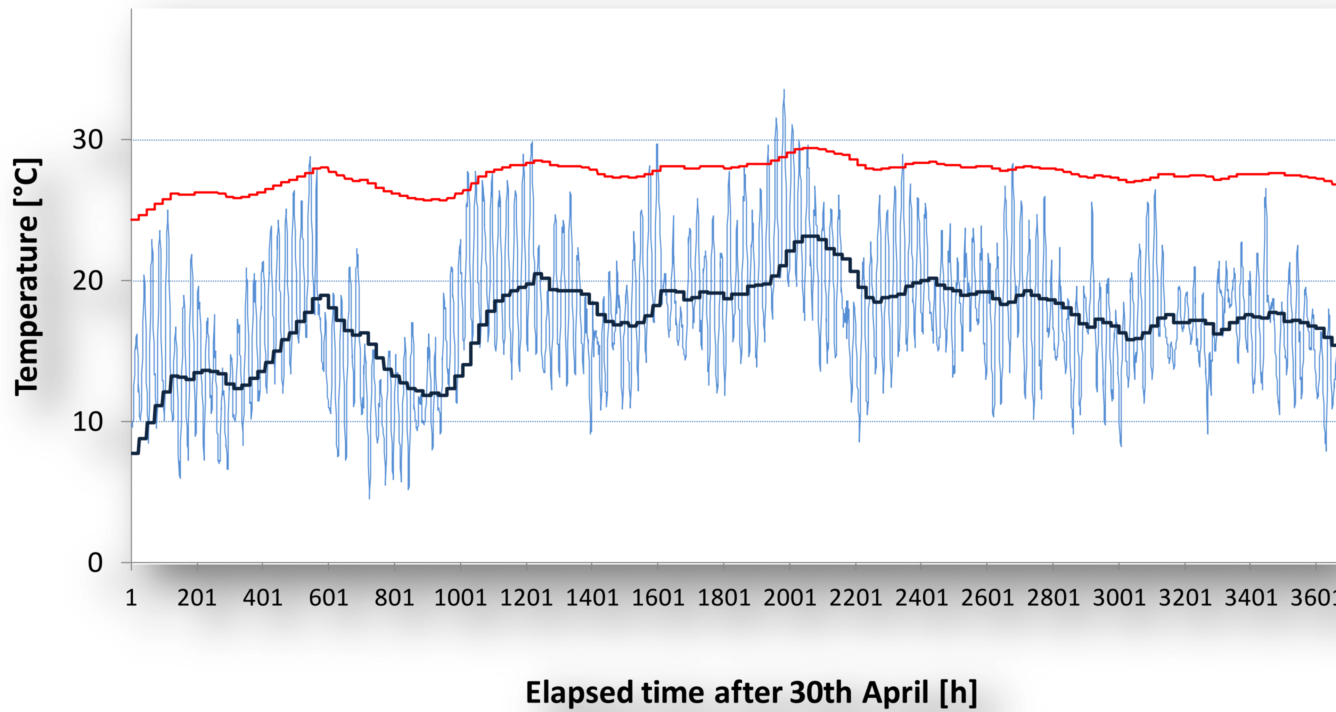
Simplified estimation techniques, design tools and analytical models

- Important to understand 'hidden', or simplifying assumptions on which they are based
- Typically used at RIBA Stage 2
- Useful to check against dynamic thermal modelling results at later RIBA work stages

- See AM11 Section 5.4

Dynamic thermal environment modelling

- Apply at RIBA Stage 3 and later
- Also pay attention to model outputs, post processing and reporting
- See AM11 Section 5.5



Dynamic thermal environment modelling – what input information is required?

- Building geometry and zoning
- Construction characteristics: opaque and glazed material properties
- Construction characteristics: solar shading (geometric or glazing property adjustments)
- Climatic data (if required, including allowances for climate change)
- Internal heat gains (latent and sensible from people, lighting, equipment, appliances)
- Ventilation and air infiltration (modelled or assumed, including controls)
- Space conditioning systems (including controls)
- Occupancy patterns and behaviour (including interactions and controls)
- See AM11 Section 5.5

Dynamic thermal environment modelling – building geometry and zoning

- Avoid unnecessary complexity (e.g. remove 'micro-spaces', or CAD / BIM artifacts)
- Ideally, make an initial assessment of the thermal environment for a small sample of typical rooms under mid-season conditions
- Further develop the model geometry as the design progresses
- (Note: Part L and EPC geometries on which thermal environment models are often based should follow industry wide conventions.)

- See AM11 Section 5.5

Dynamic thermal environment modelling – checks (Appendix E)

- Agree with client thermal comfort criteria to be assessed in relation to specified external climatic conditions
- Verify building heat transfer and occupancy-related modelling input assumptions
- Check building heat transfer and occupancy-related modelling input assumptions have been correctly interpreted and applied
- Check modelling results have been correctly extracted for post processing (if any)
- Check modelling assumptions and results have been correctly reported for the design team and client
- Update modelling assumptions, inputs and results to reflect changes at all later design stages and report these to the design team and client

Using computational fluid dynamics (CFD) for indoor thermal environment modelling

- Room surface temperature results from dynamic thermal modelling can be used as inputs for CFD
- CFD gives highly spatially detailed information on indoor thermal environments, usually varying over short time periods, or as ‘steady state’ models
- Be careful in interpreting CFD results for thermal comfort (thermal comfort models used in routine building design are based on the responses of large groups of people)

- See AM11 Section 5.6 (See Chapter 6 for more complete information)

Summary and conclusions

- Agree with your client the thermal comfort criteria for the project in early design
- But, be clear what the thermal comfort approach taken means in terms of facilities management and occupant behaviour
- Keep the criteria unchanged throughout design and construction
- Start to assess the building's thermal environment in early design
- Use dynamic thermal modelling to reduce the need for active heating or cooling by assessing how a design performs under mid-season conditions
- Update models when design changes are proposed and inform the design team and client of the implications