CONTENTS

PART I: BUILDING CLIMATOLOGY 1
CHAPTER 1: COMFORT ISSUES AND CLIMATE ANALYSIS
FOR BUILDING DESIGN 3

Introduction 3
Human Responses to the Thermal Environment 5

Effects of the Climate and Other Factors on Heat Discomfort 14

Comfort Indices and Bio-Climatic Charts 22

The Building Bio-Climatic Charts 36

References 46

Preface

CHAPTER 2: ARCHITECTURAL FEATURES AFFECTING
THE INDOOR CLIMATE 49

Introduction 49

Impacts of Building's Layout on the Indoor Climate 50

Thermal Impacts of Windows' Orientation and Shading

Conditions 53

Thermal Effect and Efficiency of Shading Devices 62

Thermal Effects of Walls' Orientation and Color 74

Natural Ventilation 87

Architectural Features Affecting Ventilation 92

Experimental Studies on Ventilation 96

References 105

CHAPTER 3: MATERIALS PROPERTIES AND THERMAL PERFORMANCE OF BUILDINGS 107

Heat Exchange Between the Building and Its Environment 108

Modes of Heat Transfer in Buildings 109

Thermal Properties of Materials and Building Elements 114

Standard Procedures of Building Heat Loss/Gain Calculation 127

Quantifying the Interactions Between Heat Capacity and Thermal

Resistance 133

References 148

CHAPTER 4: PASSIVE SOLAR HEATING SYSTEMS 149

Direct Gain 150

Collecting Storage (Trombe) Walls 159

Convective Loops: The Steve Baer System 167

The Barra System: Insulated, Glazed, Solar Wall, and Storage in Concrete Ceiling 169

Sun Spaces 171

Applicability of the Various Passive Solar Systems 179

CHAPTER 5: PASSIVE COOLING OF BUILDINGS 185

Introduction 185

Comfort (Daytime) Ventilation 186

Nocturnal Ventilative Cooling 189

Radiant Cooling 191

Evaporative Cooling Towers 196

Indirect Evaporative Cooling 200

The Earth as a Cooling Source 207

References 212

182

References

CHAPTER 6: CLIMATIC CHARACTERISTICS OF

HOUSING TYPES 213

Introduction 213

Single-Family Detached Houses 214

Town Houses (Row Houses) 217

Multistoried Apartment Buildings 220

High-Rise Buildings 230

Climatic Characteristics of Internal Courtyards and Attached

Enclosed Open Spaces 232

PART II: URBAN CLIMATOLOGY 239

CHAPTER 7: GENERAL CHARACTERISTICS OF

THE URBAN CLIMATE 241

Introduction 241

The Urban Temperature: The "Heat Island" Phenomenon 243

Overall Spatial Pattern of the Urban Heat Island 244

Heat Island Models 248

Impact of the Nocturnal Urban Heat Island Phenomenon on

Human Comfort, Health, and Energy Use in

Different Climates 254

The Urban Wind Field 256

Urban Radiation and Sunshine 266

References 273

CHAPTER 8: URBAN DESIGN EFFECTS ON THE URBAN CLIMATE 275

Introduction 275

Location of a Town within a Region 276

Effect of Size of Cities on the Urban Heat Island 280

Climatic Effects of Density of the Built-Up Area 281

Climatic Impacts of Street Width and Orientation 286

Impact of Urban Density on Energy Demand and Potential for Solar

Energy Utilization 291

Urban Density and the Urban Wind Field 293

Pedestrian Reactions to Excessively Windy Environments 295

Special Design Details of Buildings Affecting
the Outdoor Conditions 298
References 301

CHAPTER 9: IMPACT OF GREEN AREAS ON SITE AND URBAN CLIMATES 303

Introduction 303

Functions and Impacts of Urban Green Areas 304

Effect of Plants on the Environmental Conditions 306

Climatic Impact of Plants Around Buildings 308

Experimental Studies on the Thermal Effect of Planted Areas 309

Climatic Effects of Public Urban Parks and Playgrounds 318

Impact of Green Spaces on Air Pollution 320

Planted Areas as Noise Controls 322

Social Functions of Urban Parks 324

References 327

PART III: BUILDING AND URBAN DESIGN GUIDELINES 331

CHAPTER 10: BUILDING AND URBAN DESIGN FOR HOT-DRY REGIONS 333

Introduction 333

Characteristics of Hot-Dry Regions

Comfort and Energy Conservation Issues in Hot-Dry Regions

333

337

Architectural Guidelines for Hot-Dry Regions 340

Building Materials in Desert Regions 358

Building Types Considerations in Hot-Dry Climates 363

Urban Design in Hot-Dry Regions 366

References 376

CHAPTER 11: BUILDING AND URBAN DESIGN FOR HOT-HUMID REGIONS 379

Introduction 379

Climatic Considerations of Hot-Humid Regions Relevant to Building and

Urban Design 380

Architectural Guidelines for Hot-Humid Regions 382

Structural Design and Choice of Materials in

Hot-Humid Regions 397

Climatic Characteristics of Different Building Types in Hot-Humid

Regions 404

Urban Design Guidelines for Hot-Humid Regions 407

References 414

CHAPTER 12: BUILDING AND URBAN DESIGN

IN COLD CLIMATES 417

Introduction 417

Building and Extended Site Design in Cold Climates 418

Urban Design in Cold Climates 422

References 429

CHAPTER 13: REGIONS WITH COLD WINTERS

AND HOT-HUMID SUMMERS 431

Introduction 431

Climatic Characteristics and Thermal Comfort Requirements 432

Building Design Considerations 434

Urban Configuration for Regions with Hot-Humid Summers and Cold

Winters 437

Index 443