Monograph on

Planning and Design of Tall Buildings

Volume PC

Planning and Environmental Criteria for Tall Buildings

Group Coordinators

Thomas C. Kavanagh Rai Y. Okamoto Yona Friedman Rudiger Thoma

BIBLIOTHEK Konstruktiver Ingenieurbau TU Darmstadt, FB 13 Petersenstraße 12 64287 Darmstadt

Group Editors



80-65693

Roy C. Herrenkohl
Institut f. Massivbau Walter Henn
der Techn. Hochschule Darmstedt Christian Norberg-Schulz

lav.-Nr. 6559

Group Secretary

Roy C. Herrenkohl

Contents

PC-1 Philosophy of Tall Buildings Genesis of the Tall Building 1 Factors Generating Development of Tall Buildings 2 Evolution of Building Forms Identity of the Tall Building 3 Alternatives to the High-Rise 14 The Decision to Build Tall—Considerations 16 Population Density and Land Consumption 17 24 **Economics** Social and Cultural Factors 30 Symbolism and Prestige 37 Development Control 38 Transportation, Public and Private 41 Effects on Urban Environment and Climate 43 **Energy Consumption** 44 45 Use of Resources and Materials 10 Safety 47 49 11 Esthetics 12 Flexibility 51 Current Problems and Research Needs: A Decision-Making Matrix 51 1 Positive Qualities of Tall Buildings 52 2 Problems and Negative Aspects to Avoid 56 59 3 A Schematic Decision-Making Matrix Condensed References/Bibliography 77 PC-2 History of Tall Buildings 2.1 Introduction 2.2 Tall Buildings in Antiquity **Masonry Structures** 88 2.3 2.4 Iron Buildings 91 2.5 Steel Buildings

xviii	Plan	ning and Environmental Criteria for Tall Buildings	6			
	2.6	Early Buildings of Reinforced Concrete	95			5 Sp
	2.7	More Recent Developments in Reinforced Concrete Buildings	96			6 R
	2.8	Evolution of Design of Tall Buildings	99			7 Ti
	2.9	Foundations of Early Tall Buildings	101			8 C
	2.10	Legal Aspects (USA)	103		3.6	Condensed
	2.11	Social Aspects	106			
	2.12	The Development of the Elevator	106	PC-4	Socio-Po	olitical Infl
	2.13	Summary and Appendix: Historical Sketches	110			
		1 History of Tall Buildings in Australia	110		4.1	The Applic
		2 History of Tall Buildings in Colombia	116		4.2	The Social
		3 History of Tall Buildings in France	121	•		1 St
		4 History of Tall Buildings in Germany	125			2 Sc
		5 History of Tall Buildings in Italy	135		4.3	The Decisi
		6 History of Tall Buildings in Japan	146			1 Ti
		7 History of Tall Buildings in Poland	155			2 T
	2.14	Condensed References/Bibliography	164			3 TI
					4.4	A Model o
PC·3	Social F	ffects of the Environment				1 P
1 0-0	Goolai L	Tions of the Environment				2 A
	3.1	Introduction	169			3 III
	3.2	Indicators of Occupant Well-Being	171			4 In
		1 General Overview	171		4.5	Research N
		2 Indicators of Occupant Welfare	173		4.6	Conclusion
		3 Measures of Occupant Response	176		4.7	Condense
		4 Assessment of Occupant Satisfaction	. 177			
		5 Multiple Measures of Occupant Well-Being	178	PC·5	Econom	ics
		6 Summary	178	٥		
	3.3	Influences on Occupant Well-Being	178		5.1	Introducti
		1 Overview	178		5.2	History of
		2 Age and Quality of Building	179 .			1 C
		3 The Building in General	180	-3		2 F
		4 Features of Building Design	181	**		3 N
		4 Features of Building Design	101			4 7
		5 Environmental Stimuli	187			4 T
		5 Environmental Stimuli6 Design Flexibility	187 194		5.3	Economic
		5 Environmental Stimuli6 Design Flexibility7 Building Usage	187 194 195		5.3	Economic 1 N
		 5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 	187 194 195 198		5.3	Economic 1 N 2 F
		 5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 	187 194 195 198 209	* * * * * * * * * * * * * * * * * * *		Economic 1 N 2 F 3 F
		 5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 	187 194 195 198 209 214		5.3	Economic 1 N 2 F 3 F Direct Co
		 5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 	187 194 195 198 209 214 216	* * * * * * * * * * * * * * * * * * *		Economic 1 N 2 F 3 F Direct Co 1 (
		 5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 	187 194 195 198 209 214 216 221	\$. s		Economic 1 N 2 F 3 F Direct Co 1 (2 (
		 5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics 	187 194 195 198 209 214 216 221 222			Economic 1
	3.4	5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics The Role of Cultural and National Differences	187 194 195 198 209 214 216 221 222 236	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		Economic 1
	3.4	5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics The Role of Cultural and National Differences 1 Esthetic Needs	187 194 195 198 209 214 216 221 222 236 236		5.4	Economic 1 N 2 F 3 F Direct Co 1 C 2 C 3 1 4 F 5 F
	3.4	5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs	187 194 195 198 209 214 216 221 222 236 236 238	(1) (1) (1) (1) (2) (2) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4		Economic 1 N 2 F 3 F Direct Co 1 C 2 C 3 1 4 F 5 F Social Co
	3.4	5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs 3 Psychological Needs	187 194 195 198 209 214 216 221 222 236 236 238 238	· · · · · · · · · · · · · · · · · · ·	5.4	Economic 1
	3.4	5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs 3 Psychological Needs 4 Physical Health Needs	187 194 195 198 209 214 216 221 222 236 236 238 238 241	(1) (1) (1) (2) (2) (2) (2) (2) (2) (2) (2) (2) (2	5.4	Economic 1
	3.4	5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs 3 Psychological Needs 4 Physical Health Needs 5 Sociological Needs	187 194 195 198 209 214 216 221 222 236 236 238 238 241		5.4	Economic 1 N 2 F 3 F Direct Co 1 C 2 C 3 1 4 F 5 F Social Co 1 1 Appendix
		5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs 3 Psychological Needs 4 Physical Health Needs 5 Sociological Needs 6 Needs for Comfort	187 194 195 198 209 214 216 221 222 236 236 238 238 241 242	(1) (1) (1) (1) (2) (2) (3) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	5.4	Economic 1 N 2 F 3 F Direct Co 1 C 2 C 3 1 4 F 5 F Social Co 1 7 2 I Appendix Role of C
:	3.4	5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs 3 Psychological Needs 4 Physical Health Needs 5 Sociological Needs 6 Needs for Comfort Research Needs	187 194 195 198 209 214 216 221 222 236 236 238 241 242 243 245	· · · · · · · · · · · · · · · · · · ·	5.4	Economic 1 N 2 F 3 F Direct Co 1 C 2 C 3 1 4 F 5 F Social Co 1 1 Appendix Role of C 1 1
÷		5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics 14 Occupant Characteristics 15 The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs 3 Psychological Needs 4 Physical Health Needs 5 Sociological Needs 6 Needs for Comfort Research Needs 1 An International Register of Research	187 194 195 198 209 214 216 221 222 236 236 238 241 242 243 245 246		5.4	Economic 1 N 2 F 3 F Direct Co 1 C 2 C 3 1 4 F 5 F Social Co 1 7 2 I Appendix Role of C 1 1 2 C
		5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics 14 Occupant Characteristics 15 The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs 3 Psychological Needs 4 Physical Health Needs 5 Sociological Needs 6 Needs for Comfort Research Needs 1 An International Register of Research 2 Theories and Models	187 194 195 198 209 214 216 221 222 236 238 238 241 242 243 245 246 247	1997年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年,1998年	5.4	Economic 1
		5 Environmental Stimuli 6 Design Flexibility 7 Building Usage 8 Social Effects Related to Building Design 9 Social Environment 10 Management Characteristics 11 Availability of Facilities and Services 12 Neighborhood Characteristics 13 Occupant Characteristics 14 Occupant Characteristics 15 The Role of Cultural and National Differences 1 Esthetic Needs 2 Economic Needs 3 Psychological Needs 4 Physical Health Needs 5 Sociological Needs 6 Needs for Comfort Research Needs 1 An International Register of Research	187 194 195 198 209 214 216 221 222 236 236 238 241 242 243 245 246		5.4	Economic 1 N 2 F 3 F Direct Co 1 C 2 C 3 1 4 F 5 F Social Co 1 7 2 I Appendix Role of C 1 1 2 C

all Building:	S			Contents	xix
	0.5			5 Specific Research Issues	248
notifie	95			6 Research Methodology	249
e Buildings	96			7 The Role of Different Professional Groups	249
	99			8 Conclusion	250
	101		3.6	Condensed References/Bibliography	250
	103		2.0		
	106			Del al Letter and	
	106	PC	-4 SOCIO-P	olitical Influences	
	110		4.1	The Application of Tall Building Technology	257
	110		4.1	The Social and Political Environment	258
	116		4.2	1 Stages of Societal Development: The Urban Explosion	258
	121			2 Social and Political Ecology	260
	125		4,3		263
	135		4.3	The Decision-Making Process	
	146			1 The American Experience	263
	155			2 The European Experience	267
r :	164			3 The Developing Nations	270
1			4.4	A Model of Public-Private Policy-Making	272
Ì				1 Public-Private Policy Linkages	274
				2 Assessing Externalities as Policy Impacts	276
	169			3 Illustrations of Impact Review Methods	279
	171			4 Implementation	281
	171		4.5	Research Needs	284
	173		4.6	Conclusion: What Makes A City Work?	284
	176		4.7	Condensed References/Bibliography	286
	. 177				
ng	178	PC	-5 Econon	nics	
100	178				
	178		5.1	Introduction	291
	178		5.2	History of Tall Buildings	291
	179 .			1 Construction Innovations	292
	180			2 Economic Factors	293
	181			3 Noneconomic Factors	293
	187			4 The Consequences of Clustering	294
	194		5.3	Economic Analysis of Tall Buildings	295
	195		5.5	1 Market Feasibility	295
	198			2 Financial Feasibility	296
	209			3 Fiscal Feasibility	297
	214		5.4	Direct Cost of Tall Buildings	298
	216		3.4	1 Capital Cost	298
	221			2 Operating Cost	310
	222			3 Total Cost	311
	236			4 Economic Success	311
in the latest and the	236			5 Experience in India and Other Developing Countries	313
-	238		5.5	Social Costs and Benefits—The Broader Context	315
	238		5.5	1 Theoretical Approach	317
	241			2 Practical Experience	
	241		5.6	<u>.</u>	318
			3.0	Appendix—Economics of High-Rise Building Construction:	210
	243 245			Role of Construction Management in Developing Countries	319
				1 Building Economics	320
	246			2 Case Study of Delay in Execution	320
	247			3 Factors Contributing to Delays	321
	247		, -	4 Role of Construction Management	324
	248		5.7	Condensed References/Bibliography	325

Planning and Environmental Criteria for Tall Buildings XX

PC-6 Architecture

	6.1	Introduction	331			
		1 Philosophical Approaches to the Architectural Design				
		Process	333			7.3
		2 Technical Approaches to the Architectural Design Process	335			
	6.2	Influences of Primary Client on the Design Process	336			
	•	1 Developer	337			
		2 Government Agency and Institutional	340			
		3 Corporate	342			,
	6.3	Building and Zoning Regulations	342	•		
	0.5	1 Why Regulations?	342			
		2 Impact of Building Codes	-			
		•	344			
		3 Impact of Zoning Ordinances	345			
		4 Other Regulations	349			
	6.4	Priorities of User Needs	352			
		1 Various Building Types—User Needs	352			7.4
		2 Similar Design Principles for Various Building Types	358			
		3 Planning Procedures on Priorities Basis	360			
	6.5	Esthetics	378			
		1 Visual Perception	378			
		2 Structural and Mechanical Expression in Architectural				
		Design	385			
		3 Scale Relationship to Surrounding Structures	385			
		4 Space Between Buildings	387			7.5
		5 Public Identity	391			
		6 Nightscape	393			
		7 Material Selection	393			7.6
		8 Fine Arts	395			7.0
	6.6	Environmental Influences on Design	396			
	0.0	1 Thermal	397			7.7
		2 Lighting	398			1.1
			398 399			
						7.0
		4 Sun and Shadow	402		٠	7.8
		5 Wind	403			7.9
		6 Rain	405			
		7 Insects, Dust, and Smoke	405		PC-8	Urban Pi
	6.7	Ingress and Egress Influences on Design	405			
•		1 Pedestrian	406			Intro
		2 Automobile	406			8.1
		3 Parking	406			
		4 Graphic Aids	408			
		5 Emergency Situations	409			
	6.8	Condensed References/Bibliography	410			
C-7	Interfere	ence and Environmental Effects				8.2
		Later of the Detector Deliding and Engineere	416			
	7.1	Interaction Between Buildings and Environment	415			
	7.2	New Concept of Building Regulations With View to Preservation	41.0			
,		of Environmental Openness	416			
		1 Foreword: Outline of Redevelopment of Shinjuku	44.5			0.3
		Sub-City Center	416			8.3
		2 New Concept of Building Regulations for Preservation				
		of Environmental Openness	418		•	

:						
Buildings					Contents	xxi
				3	Determination of Numerical Value for New Technique	
					of Regulation	419
	331				Summary of Theory of Average Environment With	
ctural Design					Regard to Openness of Urban Space	421
	333		7.3	Interfere	ence Between Natural and Artificial Climates	428
Design Process	335				Design for Climate and Comfort	428
	336			2	Interaction Between Climate and Tall Buildings	428
	337				Role of Building Climatology	430
	340			4	Climate-Related Risk	430
	342			5	The Function of Windows	431
	342			6	Natural Lighting and Artificial Lighting	432
	342			7	Natural Ventilation and Thermal Comfort	433
	344			8	Shading Devices	433
	345			9	Air Conditioning	434
	349			10	Application of Building Climatology to Design	
	352				of Tall Buildings	435
	352		7.4	Tempera	ature and Radiation Effects	437
ding Types	358			1	Effect of Tall Buildings on Air Temperature	
	360				in City Streets	437
	378			2	Reflective Glazing	440
	378			3	Solar Radiation Reflected from Water Surfaces	445
Architectural				4	Effects of Air-Conditioning Cooling Towers	
	385				on Their Surroundings	447
ires	385			5	Ice Loading on Tall Structures	450
	387		7.5	Lighting	-	453
**	391				Reflective Glazing	453
	393				Shading Effects on Adjacent Buildings and Spaces	455
	393		7.6		c Effects	457
	395			1	Effect of Surrounding Buildings on Street Noise Levels	457
	396				Wind-Generated Noise in Tall Buildings	458
	397		7.7	Commu	nications	459
	398			1	Television Interference from Tall Buildings	459
	399				Laser and Microwave Interference from Tall Buildings	460
·	402		7.8	Guideli	nes for Land Use Involving Tall Buildings	461
	403		7.9		sed References/Bibliography	462
	405					
	405	PC-8	Heban Di	lannina	and Design	
	405	PC-6	Orban Pi	aiiiiiiy	and Design	
	406		Intro	duction		. 467
	406		8.1		on of Urban Planning	468
	406				Prehistoric Cities	468
	408				Greek and Roman Cities	472
	409			_	Medieval Period	475
	410			- 4		479
				5		483
			8.2	Pattern	s of Urban Development	487
					Factors Determining Urban Growth Patterns	488
	415				Urbanization	489
to Preservation	413				Expansion of Existing Urban Settlements	492
to I reservation	416				Remodeling Existing Towns and Cities	498
f Shinjuku	***				Development of New Settlements	505
. Jana	416		8.3		porary Urban Planning	508
r Preservation	110				Land Use Regulations	508
	418				Urban Renewal	516
					Planned Large-Scale Development	523
		3 (A) (A) (A)		-	— · · · · · · · · · · · · · · · · · · ·	

xxii	Plann	ning and Environmental Criteria for Tall Buildings	
		4 New Towns	529
		5 Innovations in Urban Design Determinants—Transit	535
	8.4	Role of Tall Buildings in Urban Space	543
		1 City Forms and the Skyline	543
		2 Freedoms of Choice in Urban Design	545
		3 Urban Functions	547
		4 Impact on the Urban Environment	551
		5 The Urban Image	552
	8.5	Summary and Need for Future Research	555
	8.6	Appendix: A Case in Environmental Impact	562
		1 Background Data	562
		2 SPUR Study Methods	564
		3 SPUR Analysis	565
		4 SPUR Results	566
		5 Downtown San Francisco Conservation and Development:	
		Background of the Planning Program	567
		6 Conclusions	570
	8.7	Condensed References/Bibliography	571
PC-9	External	Transportation	
	9.1	Background	579
		1 Historical Context	580
		2 Current Land-Use Trends	581
	9.2	Nature of Demand	582
	9.3	New Attitudes Towards Moving People and Goods	586
	9.4	Integration of Transportation with Tall Buildings	586
	9.5	New Frontiers in Urban Transportation Technology	587
	9.6	Continuum Concept of Transportation	588
	9.7	Increased Line-Haul Capacity	590
		1 Issue: Increased Line-Haul Capacity	500
		Solution: Automatic Control	590
		2 Issue: More Economic Distribution of Vehicles	e01 ·
		Solution: Small Specialized Commuting Automobiles 3 Issue: More Economic Distribution of Vehicles	591
		Solution: Attractive Rail-Auto or Bus-Auto Modal	
		Interchanges	592
	9.8	Innovations in Rail Transit Transportation	592
	9.0	1 Issue: Increasing Acceleration Rates	372
		Solution: Rubber Tire-Steel Wheel Transit Vehicle	592
		2 Issue: Increasing Acceleration Rates/Automatic Control	J,_
		Solution: Monorails	593
		3 Issue: Increasing Acceleration Rates/Automatic Control	
		Solution: Skybus	596
		4 Issue: Miscellaneous Rail Transit Innovations	597
	9.9	Innovations in Bus Transportation	598
		1 Issue: Increased Line-Haul Capacity	
		Solution: Dual-Purpose Vehicle	598
		2 Issue: Increase Line-Haul Capacity	
		Solution: Exclusive Bus Right-of-Way	599
		3 Issue: Increase Rus Distribution with Short Trips	

Solution: Minibus Operations

Issue: Air Pollution Contributed by Buses Solution: New Sources of Bus Fuel

	9.10	Technolog
	2	1 Is
		O'
		Se 2 Is
		2 Is
		S
		N
		3 Is
		. 0
	0.11	S Innovatio
	9.11	1 I
		S
		2 I
		S
		3 I
		4 I
		5 I
		6]
	9.12	Pedestria
	2	1 '
		2
		3
		4 5
	9.13	Current
		1
		2
		3 4
		5
		6
		7
	0.14	8 Conden
	9.14	
PC-10	Parking	-
	10.1	Introdu 1
		2
		3
	10.2	Plannin
		1
1.4		2
ť.		4
100		5
(* a. *)	10.3	Design

602

603

Contents xxiii ildings 9.10 Technological Innovations in Urban Air and Water Transportation 529 1 Issue: Direct Orgin and Destination of Movement 535 over Congestion 543 Solution: Helicopter or V/STOL Service 603 543 2 Issue: Direct Origin and Destination of Movement 545 over, Water 547 Solution: Technological Innovations in Ground Effect 551 Machines 605 552 3 Issue: Direct Origin and Destination of Movement 555 over Water 562 Solution: Technological Innovations in Hydrofoils 606 562 9.11 Innovations in Downtown Area Distribution Systems 606 1 Issue: More Efficient Distribution in Congested Areas 565 Solution: Moving Sidewalks 606 566 Issue: Downtown Distribution of Passengers evelopment: Solution: Carveyor System 606 567 Issue: Downtown Distribution of Passengers 570 607 Solution: Personal Rapid Transit 571 Issue: Movement of Goods in Downtown Areas Solution: Containerization 608 Issue: Movement of Goods in Downtown Areas 608 Solution: Freight Tunnels 579 Issue: Movement of Goods in Downtown Areas 609 Solution: Freight Conveyor 580 610 581 9.12 Pedestrian System Planning for High-Rise Buildings 610 1 The High-Rise Pedestrian System 582 586 Problem Definition, Goals, and Objectives 611 613 586 Methods of Study 587 Planning and Design of Pedestrian System 614 618 588 Conclusions 9.13 Current Proposals for Improved Transportation Systems 618 590 621 Boston, Massachusetts Chicago, Illinois 623 590 2 625 Montreal, Quebec, Canada Calgary, Alberta, Canada 627 mobiles 591 627 Buffalo, New York 628 Modal Singapore 630 592 Tel Aviv, Israel 631 8 Transportation Planning in Hong Kong 592 9.14 Condensed References/Bibliography 632 hicle 592 PC-10 Parking itic Control 639 10.1 Introduction 593 640 General Objective of Parking System itic Control 640 2 Preliminary Assumptions 596 641 3 Application to Tall Buildings 597 10.2 Planning 641 598 Zoning Requirements 644 1 2 **Building Codes** 646 598 647 Location 648 Size and Use 599 649 Type 5 rips 650 10.3 Design 602 650 Internal Design 1 653 **Local Conditions** 603

100 A CO.

4 Emergency Maintenance Crews

Security Incidents

6 Power Supply Failure

694

694

695

7 Em or (8 Firs

1 Exp 2 Rev

1 Ear
2 Bef
3 Acc
as F
4 Leg
5 Evin
6 Ove
7 Reg
8 Enf
9 Staf
10 Con

11.4 Financial As

11.5 Vandalism 11.6 Control of C

11.7 Refuse Colle

11.8 Cleansing

Part 2—Mainte
11.9 Maintenance

11.10 Operation a in Hong Kon
1 Plai
2 Mai
3 Stat
4 Pro
5 Cor

11.11 Maintenance

Des
 Gov
 Fina

4 Edu

5 Invo

6 Staf

1 Ren 2 Ren 3 Equ

Equ
 Prol
 Ren

Des
 Fee
 Hai
 Cen
 Inte
 The

Buildings				Contents	XXV
	653			7 Emergencies Due to Flooding, Cyclones, Hurricanes,	
i	654			or Other Natural Hazards	696
	655			8 First Aid and Ambulance Service	696
	656		11.4	Financial Aspects	696
	658			1 Expenditure	698
	661			2 Revenue	704
	662		11.5	Vandalism	706
	662		11.6	· · · · · · · · · · · · · · · · · · ·	708
	662		11.0	1 Early Management Involvement in Design	708
	662			2 Before Occupancy	709
	663			3 Acceptance by Occupiers of Responsibilities as Well	, 0,
	664			as Privileges	711
	665			•	712
				4 Legal Relationships	712
	667			5 Evidence of Owners' Intentions	712
	667			6 Overriding Priority to Estate Development	713
	668			7 Regular Functional Personal Contact with Occupants	
	670			8 Enforcement	716
	670			9 Staff	717
	672			10 Conclusion	718
	673		11.7	Refuse Collection	718
	673			1 Removal from Individual Unit	718
	674			2 Removal from Building	720
	674			3 Equipment	721
ith Africa	675		11.8	Cleansing	721
a2	678			1 Equipment and Materials	722
				2 Problems	722
				3 Remedies	722
	681				
all Buildings	681 682		Pa	rt 2—Maintenance	
	683		11.0	Maintanana of Samilara as a Blanning Criterian	723
nant Relations	684		11.9	<u> </u>	723
ole-Owned	•			1 Designing for Optimum Economy	
ole-Owned	686			2 Feedback	724
:_	000			3 Handover	725
in	687			4 Centralization	725
`	690			5 Integrated Environmental Design	726
	-			6 The Company Balance Sheet	726
	690		11.1	O Operation and Maintenance of Air-Conditioning Systems	
	690			in Hong Kong: A Case Study	726
ations	691			1 Plant Considerations	727
У	691			2 Maintenance and Plant Life	727
	692			3 Staffing	729
	692			4 Problem Areas	730
	692			5 Conclusion	730
	693		11.1	1 Maintenance of Amenity Areas	730
	693			1 Design Affecting Maintenance	731
	693			2 Governmental Agencies	733
	693			3 Financing	733
	694			4 Education in Proper Usage	735
	694			5 Involvement of Residents' Associations in Maintenance	735
	695	2.0		6 Staff Functions	736
				o stati i unictions	, , 0

xxvi Planning and Environmental Criteria-for Tall Buildings

	Part 3	3—Ownership	
	11.12	Multiple Ownership	737
		1 History of Condominiums	737
		2 The Condominium	737
		3 Condominiums in the United States	738
		4 Time Sharing	740
	•	5 General Comments	741
	11.13	Single Ownership	742
		1 Single Owner: Development	742
		2 Management of Office Buildings	744
	11.14	Condensed References/Bibliography	. 748
PC-12	Energy (Conservation	
	12.1	Energy Issues	753
	12.1	1 Conservation: The Road not Taken	754
		2 Energy Conservation: An Awakening	754
		3 Justification for Energy Conservation Efforts	755
		4 Energy Issues in Tall Buildings	`756
		5 New Directions for Tall Buildings	757
	12.2		759
		Energy System Hardware and	
	12.3	Energy Conservation	
		1 Domestic Water System	761
		2 Fire Protection System	764
		3 Heating, Ventilating and Air-Conditioning (HVAC)	
		System	765
		4 Heat Recovery and Thermal Storage	774
		5 Lighting	778
		6 Vertical Transportation	781
		7 Electric Power	783
		8 Congeneration	783
		9 Energy Management and Control Systems	785
		10 The Building Envelopes	788
	12.4	Tools for Analyzing Energy Usage	789
		1 Energy Flow Diagrams	789
		2 Value Guides for Energy Decisions	793
		3 Energy Design Evaluation Guide	794
		4 Procedures for Design and Analysis of Energy	
		Efficient Buildings	795
	12.5	Trade-offs for Minimal Energy and Life-Cycle Cost	796
		1 Systems Integration for Energy Efficiency	796
		2 Life Cycle Costing	798
	12.6	Condensed References/Bibliography	799
PC-13	Motion	Perception and Tolerance	
	13.1	Introduction	805
	13.2	Tall Building Motions	807
		1 Motion Characteristics and Human Responses	807
		2 Motions Caused by Wind Forces	812
		3 Motions Caused by Earthquakes and Other Loading	
		Sources	815

	13.3	Human P	>
		2 1	
	12.4	3 7	
	13.4	Experime 1 H	
		1 H 2 H	
	13.5	Design C	
	13.3	1 I	
		2 1	
	13.6	Conclusio	
		1 1	
		2 1	r
		3 I	₹
		4 1	V
		5 I	ľ
		6 A	١
		7 /	
		8 I	
		9 I	
		10 I	
		11 (
	13.7	Condense	1
~ 4 4	Drainat	Managa	_
C-14	Project	Manage	li
J-14	14.1	Introduct	
J-14	•	Introduct	j
J-14	•	Introduct	i -
J-14	14.1	Introduct 1 (2 I	1
J-14	•	Introduct 1 (2 I Project M	1
J-14	14.1	Introduct 1 C 2 H J Project M	1
<i>j</i> -14	14.1	Introduct 1 (2 I Project M 1 I 2 I	1
J-14	14.1	Introduct	1
J-14	14.1	Introduct	1
<i>J</i> -14	14.1	Introduct	i
<i>J</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct 1	1
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct	i
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1	Introduct 1	i
<i>j</i> -14	14.1 14.2 14.3	Introduct 1	i
	14.1	Introduct 1	i
3-14	14.1 14.2 14.3	Introduct	i

Tall Buildings	i			Contents	xxvii
and the second s			13.3	Human Perception and Tolerance of Motion	817
				1 Psychological Response	817
	737			2 Kinesiological and Physiological Reactions	823
ì	737			3 Total Effect for Tall Building Environment	835
	737		13.4	Experimental Research	839
	738			1 Research Conducted for Other Motion Environments	839
	740			2 Research Conducted Specifically for Tall Buildings	841
	741		13.5	Design Criteria and Methodologies	849
	742			1 Human Comfort Design Criteria	849
	742			2 Implementing Human Comfort Design Criteria	851
	744		13.6	Conclusions and Needs for Future Research	856
	. 748			1 Denial Method	857
				2 Improved Passive Design	857
				3 Re-education and Genetic Change	858
				4 Minimize Motion Perception Methods	858
i	753			5 Increase Damping in Structure	858
	754			6 Addition of Untuned Passive Vibration Absorbers	858
ng	754			7 Addition of Tuned Passive Absorbers	858
n Efforts	755			8 Energy Methods, Open Loop	859
	756			9 Energy Input Methods, Closed Loop	859
	757			10 Information Input Methods, Closed Loop	859
	759			11 Conclusion	860
			13.7	Condensed References/Bibliography	860
	761	PC-14	Project	Management	
	764				
tioning (HVAC)			14.1	Introduction	865
	765			1 Overview	865
	774			2 Project Management Concept and its Application in	
	778			High-Rise Buildings	870
	781		14.2	Project Management Process	871
	783			1 Feasibility Studies and Economics of High-Rise Buildings	871
	783			2 Financial Planning	887
ystems	785			3 Value Analysis in Tall Buildings	900
	788			4 Construction Management and Contracting Practices	918
	789			5 Beneficial Occupancy	929
	789		14.3	Current Project Management Methodologies	93
	793			1 Scheduling for Tall Buildings	931
	794			2 Cost Management Using Historical Data	948
s of Energy			•	3 Resource Planning and Allocation	952
	795			4 Multi-project Management	964
ele Cost	796			5 Problem Areas in Network Planning and Comments	
ciency	796			on Legal Applications	97
	798			6 Some Shortcomings in Current Practices	983
	799		14.4	Some General Project Management Approaches	98:
				1 Information Process and Data Structure	985
				2 Planning Process and Tools	99
				3 Systems Approach	99
	805			4 Data Organization in Construction Projects	99
	807		14.5	Management Methodologies of the Future	100
Decnances	807			1 The Changing Environment	100
Responses	812			2 Special Problems in Tall Buildings	100.
d Other Loading	J12			3 Research Needs in Management Methodologies	100
ia Juici Egading	815			4 Technology and the Future	100
	415	10 miles (10 mil			

xxviii	Planr	ning and Environmental Criteria for Tall Buildings		
		5 Computer Applications in Construction	1010	
		6 A Hypothetical System	1012	
	14.6	Education and its Role in Application of New Project		
		Management Methodologies	1015	
		1 Graduate Education in Project Management	1015	
		2 Postgraduate and Continuing Education	1018	
	14.7	Summary and Conclusions	1022	
		1 Basic Factors Affecting Project's Success	1023	
		2 Inherent Flaws in Sequential Design and Construction	1023	
		3 Project Management Principles	1025	
		4 Project Management Functions	1025	
		5 The Construction Manager Approach	1026	
		6 Construction Management Activities	1026	
		7 Project Management Information Systems	1028	
		8 Developing Project Management Information Systems	1029	
		9 Evaluating and Controlling the Project	1030	
		10 The Project Manager and the Project Team	1031	
		11 Project Management Training	1031	
	14.8	Condensed References/Bibliography	1032	
PC-15	Applica	tion of Systems Methodology		
	15.1	Introduction	1037	
	15.2	Systems Methodology	1038	
		1 Introduction to Systems Methodology	1038	
		2 Survey of Systems Theory and Techniques	1045	
	15.3	Computer-Aided Building Design	1055	
		1 Current Design Practice	1056	
		2 Computer-Aided Building Design	1059	
	15.4	Applications and Case Studies	1068	
		1 Economic Optimization of Tall Buildings	1068	
		2 Site Planning with Tall Buildings	1086	
		3 Applications in Various World Regions	1092	
	15.5	Conclusion	1106	
	15.6	Condensed References/Bibliography	1107	
Curren	t Questic	ons, Problems, and Research Needs	1113	
Nomer	clature	•	1121	
	Gloss	sarv	1121	
	Symb	•	1151	
	-	eviations	1154	
	Units		1158	
Refere	nces/Bil	pliography	1161	
Contri	butors		1261	
Buildir	ng Index		1267	
Name Index				

Subject Index

Planning Environm

Prepared by Co Council on Tal Monograph on t

Cortin

180

1289