M. Arch.

IN

ENERGY EFFICIENT AND SUSTAINABLE ARCHITECTURE

CURRICULUM and SYLLABUS

(For students admitted in 2016-17)

DEPARTMENT OF ARCHITECTURE
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015

TAMIL NADU, INDIA

M. Arch.

(ENERGY EFFICIENT AND SUSTAINABLE ARCHITECTURE)

CURRICULUM

The total minimum credits for completing the M.Arch. programme in ENERGY EFFICIENT AND SUSTAINABLE ARCHITECTURE is 60 .

SEMESTER - I

Sl.No.	CODE	COURSE OF STUDY	L	T	P	C
1	AR701	ENERGY, ENVIRONMENT & BUILDINGS	2	-	-	2
2	AR703	BUILDING SCIENCE & SUSTAINABILITY	3	-	-	3
3	AR705	SOLAR PASSIVE ARCHITECTURE	3	-	-	3
4	AR707	ASSESSMENT OF BUILT ENVIRONMENT	3	-		3
5	AR709	BUILDING ENERGY ANALYSIS STUDIO	-	-	6	3
6		ELECTIVE – I	2	-	-	2
7		ELECTIVE – II	2	-	-	2
			15	-	6	18

SEMESTER – II

Sl.No.	CODE	COURSE OF STUDY	L	T	P	C
1	AR702	BUILDING ENERGY AUDIT & MANAGEMENT	3	-	-	3
2	AR704	GREEN ARCHITECTURE	2	-	-	2
3	AR706	LIGHTING DESIGN	3	-	-	3
4	AR708	ENERGY EFFICIENT LANDSCAPE DESIGN	3	-	-	3
5	AR710	BUILDING MODELLING & SIMULATION LAB	-	-	6	3
6		ELECTIVE – I	2	-	-	2
7		ELECTIVE – II	2	-	-	2
			15	-	6	18

SEMESTER – III

Sl.No.	CODE	COURSE OF STUDY	L	T	P	C
1	AR747	DISSERTATION PHASE – I	-	-	24	12

SEMESTER – IV

Sl.No.	CODE	COURSE OF STUDY	L	T	P	C
1	AR748	DISSERTATION PHASE – II	-	-	24	12

LIST OF ELECTIVES

Sl. No.	CODE	ELECTIVES	L	T	P	C
1	AR711	STATISTICS FOR ENVIRONMENTAL DESIGN	2	-	-	2
2.	AR713	ENVIRONMENT & BEHAVIOUR	2	-	-	2
3.	AR715	ENVIRONMENTAL LIGHTING	2	-	-	2
4.	AR717	NATURAL VENTILATION	2	-	-	2
5.	AR712	RESEARCH METHODS	2	-	-	2
6.	AR714	HEALTHY BUILDINGS	2	-	-	2
7.	AR716	INTELLIGENT BUILDINGS	2	-	-	2
8.	AR718	POST OCCUPANCY EVALUATION OF BUILDINGS	-	-	4	2

SYLLABUS

AR 701 – ENERGY, ENVIRONMENT & BUILDINGS

Nature and extent of the energy and environmental crises facing the world and the country. Need for implementing energy efficiency on an international, national and individual basis in the context of the building industry & environmental issues. Energy consuming sectors in the country. Primary, delivered and end – use energy.

Indoor environment – spatial environment, Thermal environment, visual environment, sonic environment and olfactory environment. Concept of Total Comfort. Human comfort and its assessment. Factors influencing comfort in solar passive buildings. Concept of embodied energy. Embodied energy for material and building component. Energy for production of building materials. Total energy need for building.

Functional factors, environmental factors, envelope factors, air-conditioning systems factors, energy source factors and electrical systems factors. Energy conservation / efficiency codes and Regulations.Methods & Techniques of energy performance assessment of buildings.

REFERENCES:

1. Baker Nick and Steemers Koen, “Energy and Environment in Architecture”, E & FN Spon, London, 1999.
2. Goulding, John, R., Lewis, Owen, J., and Steemers, Theo, C., “Energy in Architecture”, Bastford Ltd., London, 1986.
3. Bansal Narendra, K., Hauser Gerd and Minke Gernot, “Passive Buildings Design: A Hand book of Natural Climatic Control”, Elsevier Science, Amsterdam, 1994.
4. Givoni, B., “Man, Climate and Architecture”, Elsevier, Amsterdam, 1986.
5. Smith, R. J., Phillips, G. M., and Sweeney, M., “Environmental Science”, Longman Scientific and Technical, Essex, England, 1982.
6. Watson Donald, “Climate Design: Energy Efficient Building principles and practices”, McGraw Hill Book Company, New York, 1983.

AR 703 – BUILDING SCIENCE AND SUSTAINABILITY

Heat transfer processes in buildings. Thermal conductivity, resistance, transmittance, surface characteristics, surface coefficient, heat capacity, insulation.

Calculation of principle building energy gains and losses. Estimation of building energy performance for heating and cooling for different climatic contexts.

Importance of energy to human development, conventional and renewable energy sources – supply, uses and environmental impact. Assessment future growth in energy demand, availability, potential for sustainable development. Sustainable issues of planning, building design and development.

References:

1. Baird, George **The architectural expression of environmental control systems** 2001.

2. Faber, Oscar and Kell, J.R. **Heating and air-conditioning of buildings.** 2002.

3. Thomas, Randall & Fordham Max **Sustainable urban design:an environmental approach"** 2003.

4. Edwards, Brian and Hyett, Paul **Rough guide to sustainability** 2001.

5. Langston, Craig A. and Ding, Grace **Sustainable practices in the built environment** 2001.

6. Givoni Baruch,"**Passive and Low Energy Cooling of Buildings**",VNR, New YorK, 1994.

7. Martin J Gainsborough, Radford and Helen Bennets, T J Williamson, "Understanding Sustainable architecture", Spon Press, London, 2003.

AR 705 – PASSIVE SOLAR ARCHITECTURE

Classification of passive cooling systems according to the major natural source from which the cooling energy is derived. Minimizing cooling needs by building design: building shape & layout, orientation, size of windows, shading of window, colour of the envelope and climatic impact of plants around building.

Radiative cooling –The earth as a cooling source for buildings. Cooling of attached outdoor spaces. Passive solar configuration – outline of various passive systems for heat gain. Direct Gain, Indirect Gain – Trombe wall, Water wall and Transwall. Sun space / attached solarium / conservatory. Roof Pond / Skytherm – Vary Therm Wall – Earth sheltered / earth bermed structures and earth-air tunnels. The use of earth-air tunnels to heat or cool the buildings.

REFERENCES:

1. Givoni Baruch, "Passive and Low Energy Cooling of Buildings", Van Nostrand Reinhold, New Yord, 1994.
2. Sodha, M., Bansal, N. K., Bansal, P. K., KuMEB, A., and Malik, M. A. S., "Solar Passive Buildings", Pergamon Press, Oxford, 1986.
3. Bansal Narendra, K., Hauser Gerd and Minke Gernot, "Passive Buildings Design: A Hand book of Natural Climatic Control", Elsevier Science, Amsterdam, 1994.
4. Goulding, John, R., Lewis, Owen, J., and Steemers, Theo, C., "Energy in Architecture", Bastford Ltd., London, 1986.

AR 707 – ASSESSMENT OF BUILT ENVIRONMENT

Evolution and conceptual framework of building performance evaluation. Methods and phases of assessing building performance – strategic planning effectiveness review, program review, design review, construction commissioning, post occupancy evaluation, adaptive reuse/recycling – market/needs assessment.

Bench marking the sustainability of a building project. Case studies of assessing the performance of buildings. Human elements in building performance evaluation. Tools for performance evaluation.

Reference:

1. Preiser Wolfgang F E and Jacqueline C Vischer, "Assessing Building performance" Elsevier limited, London, 2004.
2. Mat Santamouris, "Energy performance of residential buildings", James & James, London, 2005.
3. Katrina Buff (ed), "Energy & High performance facility source book", Fairmont Press, Lilburn 2003.
4. Wolfgang F E Preiser, " Building Evaluation", Springer, 1989.

AR 709 – BUILDING ENERGY ANALYSIS STUDIO

Exploration of a range of analytical and design tools. Understanding of capabilities of limitations of various energy analysis tools.

Tools to be explored – Solar shadow modeling tools, heat flow analysis, light simulation tools, modeling of ventilation, fire dynamics, sizing of passive solar features, estimation of energy

conservation. Studio projects involve design and evaluation of buildings to demonstrate energy analysis and efficiency of building designs.

References:

1. Dennis Landsberg & Ronald Stewart, "Improving Energy Efficiency in Buildinngs : A management guide", State University of New York Press, Albany, 1980.
2. M. Santamouris, "Energy Performance of Residential Buildings", James & James, London 2005.
3. Moncef Krarti, " Energy Audit of Building Systems: an Engineering approach" CRC Press, LLC, Florida 2000.
4. Chris P Underwood and Francis W H Yik, " Modelling methods for Energy in Buildings", Blackwell publishing co., Oxford 2004.
5. Katrina Buff (ed),"Energy & High performance facility source book", Fairmont Press, Lilburn 2003.

AR 702 – BUILDING ENERGY AUDIT AND MANAGEMENT

An overview of energy consumption and its effects. Current energy consumption scenario in India. Need to reduce emissions. Aims and main aspects of energy management of buildings. Benefits and methodology for conducting the Historical Energy audit. Objectives & benefits and conducting Diagnostic Energy Audit. Instrumentation.

Energy management matrix as a tool to diagnose the current state of energy management in any given organization. Management issues covered in the matrix – energy policy, organization, motivation, information systems, Marketing & investment. Determining the organizational profile. Monitoring & Targeting of energy use.

Identification of opportunities for reducing energy consumption – improvements to the building fabric & building services.

Details of building energy survey – building information, building physical data, building envelope construction details, mechanical systems, electrical systems & equipment, hot water systems, indoor environmental conditions for each space, control systems and operating schedules.

Energy use profile, maintenance schedule, and special energy conservation features observed. Energy conservation program. Comment & suggestions to improve energy savings. Tables of: energy costs-comparative analysis; energy usage in MJ-comparative analysis and summary sheet – total energy cost & consumption.

References:

1. *Moss J. Keith, "Energy Management and Operating Costs in Buildings", E & FN Spon, London, 1996.*
2. O'Callaghan, Paul, W – "Buildings for Energy Conservation", Pergamon Press, London, 1980
3. Levermore Geoff, "Building Energy Management Systems", E&FN Spon, London, 2000.
4. Moncef Krarti, "Energy Audit of Building Systems: an Engineering approach" CRC Press, LLC, Florida 2000.
5. Albert Thulmann & William J Younger, " Handbook of Energy Audits", The Fairmont Press, 2003.

AR 704 - GREEN ARCHITECTURE

Definition of Green Building. Impact of design, construction & maintenance of buildings on our environment and natural resources. Benefits of building green. Design of buildings to use renewable energy, optimization of materials use, design of water-efficient, landscaping, recycling waste, use of "gray water". Siting & Land Use

Materials –choosing low-maintenance, low embodied energy recyclable building materials. Equipment –high-efficiency heating or cooling equipment, lights and appliances and installing water-efficient equipment.

Job Site & Business – protecting trees and topsoil during site work, minimizing job-site waste, making business operations more environmentally responsible. Life cycle costing of the building and components including the economic & environmental impact and performance.

REFERENCE:

1. Wines James & Jodido Philip, "Green Architecture – The Art of Architecture in the age of Ecology", Tachen Publishers, New York, 2000.
2. Mackenzie Dorothy, "Green design: design for the Environment", Laurence King, London, 1997.

3. Farmer John & Richardson Kenneth, "Green Shift: Changing attitudes in architecture to the Natural World", Architectural Press, Boston, 1999.

4. The European Commission, "A Green Vitruvius: Principles and Practices of Sustainable Architectural Design", James & James, London, 1999.

5. Fred A. Stitt, "The Ecological Design Handbook", McGraw Hill, New York, 1999.

6. Scott Andrew, "Dimensions of Sustainability: Architecture, Form, Technology, Environment & Culture", F&FN Spon, London, 1998.

AR 706 – LIGHTING DESIGN

Electromagnetic spectrum. Visual response visual acquity, Glare & visual comfort. Colour perception, Visual Task Requirements. Side lighting concepts, Top lighting concepts. Designing Atria / Light Courts. Daylight Controls. Daylighting Design, Daylighting Analysis

Electrical light sources and Luminaires. Task requirements, point-by-point method, Lumen method, Qualitative calculations and Supplementary Artificial Lighting.

REFERENCES:

1. Benjamin Evans, "Daylight in Architecture", McGraw Hill Book Co., New York, 1981
2. Pritchard,D.C., "Lighting", Longman Scientific & Technical, Harlow, 1995
3. MEBc Schiler, "Simplified Design of Building Lighting", John Wiley & Sons, Inc., New York, 1992
4. Hopkinson, R. G., "Architectural Physics – Lighting", HMS Office, London, 1963
5. Tregenza Peter & Loe David, "The Design of Lighting", E & FN Spon, London, 1998.

AR 708 - ENERGY EFFICIENT LANDSCAPE DESIGN

The climatic impact of natural elements. Thermal properties of commonly used building materials for outdoor spaces. Site analysis processes & techniques. Site selection, siting & orientation for energy conservation. Integration of building & site for energy conservation. Site planning, Site design for energy conservation.

Selection & use of landscape elements for microclimatic modification, Radiation modification, Wind modification, Temperature, humidity & precipitation modification.

Water conserving landscape design. Conservation of embodied energy thro landscape design. Human thermal comfort in outdoor spaces. Eco sensitive, sustainable landscapes.

REFERENCE:

1. Gray, O., Robinetle, "Landscape Planning for Energy Conservation", Van Nostrand Reinhold, New York, 1984.
2. Geiger, R. "The Climate near the Ground" Harvard University Press, Cambridege, Massachusetts, 1965.
3. McPherson, E. G. "Energy Conserving site Design" American Society of Landscape Architects, 1984.
4. MEBsh, W. M., "Landscape Planning Environmental Applications", John Wiley & Sons Inc., New York, 1991.
5. Oke, T. R., "Boundary Layer Climates" 2nd edition Melthuen & Co. Ltd., London
6. Robers D. Brown, Terry J. Gillespie, "Microclimatic Landscape Design", John Wiley & Sons, Inc., New York.

AR 710 – BUILDING MODELLING & SIMULATION

Creating primitive objects. Moving objects in 3D space. 3D modeling data and operations; Solids (geometry+ topology); Creating "cameras", projections from 3D to 2D, saving3D images. Creating a shading group. Placing texture maps on an object. Adding lighting to a scene. Test rendering a single frame. Setting up motion blur. Rendering images using the software renderer. Applications of 3D animation. Survey of modeling tools. Basic concepts in GIS and CAD/GIS data interchange techniques, Creating a contoured base-map, developing a surface model, developing a slope map, aspect map.

Introduction to virtual reality and virtual environments. Issues covered will include VR technology, software design, 3D human-computer interaction, and applications of VR.

REFERENCE

1. McCullough, Malcolm, William J. Mitchell Patrick Purcell, The Electronic Design Studio, Architectural Knowledge and Media in the Computer Era, ISBN**:** 0262132540 MIT Press, June 1990
2. Omura, Georage, "Advanced techniques in AutoCAD", BPB Publications, New Delhi.
3. Elliot, Steven, Miller, Philip & Pyros, Gregory, "Inside 3D Studio - Release 3", New Readers Publications, Indianapolis.

AR 711 – STATISTICS FOR ENVIRONMENTAL DESIGN

Probability: Introduction to concepts of probability. Subjective concepts related to Random variables – Density function – Distribution functions – Jointly distributed random variables – Marginal Distributions – Conditional distributions – Independent random variables.

Binomial, Poisson and Normal Distributions. Data Visualization and analysis for Curve fitting – Multiple and partial correlation – regression. Introduction to ANOVA.

Type I and II errors in testing – tests concerning mean, proportion and variances (small and large sample tests) – T test for single mean, difference between two sample means – F test for variances of two samples. Working with statistical software to handle large sets data. Testing of Signifance, Hypothesis, ANOVA conducting and reporting of Statistical investigations.

REFERENCES:

1. Allen A. O., “Probability statistics and Queuing theory with computer science applications”, Academic press, 1978.
2. Gibra, I. N., “Probability and Statistical Interference for Scientists and Engineers”, Prentice Hall, 1982.
3. Pinney, W. E. & Mcurrilans, “An introduction to Quantitative Analysis for Management”, Harper and Row publishers, New York, 1982.

4. Trivedi, K. S., “Probability and Statistics with Reliability, Queuing and Computer application”.

5. Daleh Bester Field, “Quality Control”, Prentice Hall of India, 1986.

6. Frvend John, E., and Miller Irwin, “Probability and Statistics for Engineers”, Prentice Hall, New York.

AR 713 – ENVIRONMENT AND BEHAVIOR

Prediction of environmental attitudes and behavior. Environmental assessment. Environmental Perception and cognition. Perspectives on perception, learning, habituation and perception of change. Models and acquisition of spatial cognition and cognitive maps. Way finding, characteristics, settings.

Introduction to the theories of Environment-Behavior relationships. The nature and function of theories. Arousal approach, stimulation approach, Adaptation level, Behavior constraint and Environmental stress approach. Barker’s ecological psychology approach.

Environment and Behavior studies related to Noise, Weather, Climate, Territoriality, Disasters, Crowding. Issues related to built environment such as design of residential, institutional, work, learning and leisure environments.

REFERENCES:

1. Morgan, T., & Clifford, "Introduction to Psychology", Tata McGraw - Hill Publications New York, 1983.
2. Kayem, S.M., "Psychology in relation to design" Dowden, Hutchinson and Ross, 1973.
3. Hall, E.T., "The Hidden Dimension" New York, Doubleday, 1966.
4. Bell, A. Paul, Greene, C. Thomas, Fisher, D. Jeffrey, Baum Andrew, “Environmental Psychology” Harcourt Brace College Publishers, New York, 1996.

AR 715 – ENVIRONMENTAL LIGHTING

Lighting Design – Effect of light on user orientation, room comprehension, form, structure and materials. Impressions of visual clarity, spaciousness, relaxation, privacy etc. Interior lighting design requirements for offices, factories, commercial interiors, museums and galleries, etc.

Exterior lighting: Functional requirements, buildings and facades, pedestrian routes and surrounding areas, parking areas and landscape lighting. Emergency lighting: Escape lighting, shutdown lighting and standby lighting, equipment and system design. Integration of daylight and artificial lighting. Economics of supplementary lighting.

Cost-effective daylighting design, energy efficiency and maintenance. Lighting cost, performance of lamps and luminaries. Estimating energy use. Energy saving developments.

REFERENCES:

1. Hopkinson,R.G., "Architectural Physics – Lighting", HMS Office, London, 1963
2. Millet MEBietta,S.,"Light Revealing Architecture", Van Nostrand Reinhold, New
3. York, 1996.
4. Sorcar Prafulla, C., "Architectural Lighting for Commercial Interiors", John Wiley & Sons, New York, 1987.
5. Michael Lov," Light: The Shape of Space", Van Nostrand Reinhold, London, 1995.
6. Pritchard,D.C., "Lighting", Longman Scientific & Technical, Harlow, 1995
7. Tregenza Peter & Loe David, "The Design of Lighting", E & FN Spon, London, 1998.

AR 717 – NATURAL VENTILATION

Natural ventilation & energy efficiency. Wind – its characteristics & significance. The atmosphere boundary layer. Wind pressure & wind pressure coefficient. Functions of ventilation – supply of fresh air, physiological cooling and nighttime cooling of buildings. Ventilation requirements of various buildings & spaces. Ventilation standards.

Ways of natural ventilation – single side ventilation, cross ventilation, stack effect and reverse stack effect. Dissipation of structural heat. Ventilation strategies for various climatic zones in India. Air movement around the buildings and air movement through the buildings. Effects of building form and orientation. Fenestration design of buildings to enhance air movement and ventilation.

Natural ventilation – prediction, measurement & Techniques of evaluation. Effects of shading devices on indoor air velocity. Effect of area of openings on average indoor wind velocity. Effect of size of inlet on the performance efficiency. Use & application of ventilation analysis software.

REFERENCES:

1. Awbi Hazim,B., "Ventilation of Buildings", E&FN Spon, London, 1995
2. Croome, Dereck (ed.), "Naturally Ventilated Buildings", E&FN Spon, London, 1997
3. Moss,Keith,J., "Heat and Mass Transfer in Building Services Design", E&FN Spon, London, 1998. (Chapter 8 on Natural Ventilation in Buildings)

AR 712 - RESEARCH METHODS

Research aims and philosophy; research paradigms. Literature search and review; the use of libraries and databases; aim and structure of a literature review. Presentation; Introduction to scholarly writing; writing and publishing a paper; writing and presenting a conference paper; presentation of scientific research.

Analysis of a new problem, principles of experimental design, field surveys, theoretical models and laboratory experiments. Introduction to behavioral research and physical research.

Behavioral research: Obtain data; questionnairies, interviews, un-obstrusive & obstrusive measures; scales such as a semantic differentials. Physical research: laboratory; resources available; equipment for laboratory and site measurement.

REFERENCES:

1. Giere, R.N."Understanding Scientific Reasoning",Holt, Rinehart & Winston, U.K., 1991
2. Moroney, M.J., "Facts from figures", Penguin, 1990.
3. Day, R.A. "How to write and publish a Scientific paper", Cambridge University Press, R.K., 1991.
4. Seigel, S. & Castellan, N.J., "Nonparametric Statistics for the Behavioral Sciences", McGraw - Hill Book co., New York, 1988.
5. Barzun, J & Graff, HF "The Modern Researcher" New York, Harcourt Brace Jovanovich, 1992.

AR 714 – HEALTHY BUILDINGS

Design of basic air conditioning system for buildings. Process of air conditioning system selection, heat load estimation, and design of air distribution. Air conditioning design for energy efficiency. A C system components : Fans, coils, filters and heat rejection equipment. Sick building syndrome, Issues of Indoor air quality.

Fundamental principles of fire safety engineering. Fire safety in large modern buildings, fire detection and suppression systems. Design of manual and automatic water based systems to warn / extinguish fires. Alternatives to conventional prescriptive design.

Healthy buildings theory. Performance of building services against standards. Work place standards of health. Observation and analysis of health risk in buildings, and maintenance requirements. Environmental and health impact of building materials.

Investigations of healthy living practices: washing people, washing clothes, removing waste, improving nutrition, reducing crowding, separating people from animals, vermin or insects, reducing dust, controlling temperature and reducing trauma.

References:

1. Chadderton, D. V., “Air Conditioning: A practical Introduction”, E & FN Spon, London.
2. Abrams, D. W., “Low Energy Cooling: A Guide to the practical Application of Passive Cooling and Cooling Energy Conservation Measures”, Van Nostrand Reinhold Co., N Y
3. Stoecker, W. F., “Refrigeration and Air Conditioning”, Tata McGraw Hill, New Delhi.
4. Torr, A. R., “Refrigeration and Air Conditioning”, Butterworth publishers, London, 1989.
5. Chadderton, David, V., “Building Services Engineering”, E & FN Spon.

AR 716 – INTELLIGENT BUILDINGS

Significance of Intelligent buildings. Artificial intelligence, knowledge based systems, artificial neural networks, genetic algorithms, fuzzy controls. Composition of intelligent buildings – physical building intelligence, building management and operation. Economical and technical aspects of intelligent building technologies. Facilities management for intelligent buildings.

Building automation systems - approaches, application – lighting, security, fire detection, office automation, vertical transportation, surveillance. Technologies – field devices, digital

controllers, system controllers, man-machine interface, Sensors.Automation control strategies.

References:

1. Derek Clements – Croom (ed), "Intelligent Buildings: Design, Maintenance and Operation, Thomas Telford, London, 2004.
2. Michael Nigginton & Jude Harris, "Intelligent skins" Architectural Press, Oxford, 2002.
3. Albert Ting-Pat so & Wai Lokchan, "Intelligent Building Systems (The international series on asian studies in computer and information science), Springer, 1999.
4. Andrew Harrison & Eric Loe, "Intelligent Buildings in South East Asia", Spon Press, 1997.

AR 718 - POST OCCUPANCY EVALUATION OF BUILDINGS

Assessing existing buildings on their energy use, environmental impact and occupant satisfaction. Building performance bench marks – rating and comparison of buildings. Techniques, methods & procedures of Post Occupancy Evaluation.

Students are required to carry out post occupancy evaluation of a building and document the relationship between building design, energy use, occupant satisfaction, environmental impact and report their observations.

References:

1. Wolfgang Preiser & Edlaine Ostroff "Universal Design Handbook",McGraw Hill, 2001.
2. Robert B. Bechtel and Arza Churchman "Handbook of Environmental Psychology", John Wiley & Sons Inc., New York 2002.
3. James Douglas "Building Adaptation", Elsevier, Oxford 2002.