Załącznik 2

Memorandum: Teachings of Building Physics for Universities and Scientific Colleges

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Teachings of Building Physics for Universities and Scientific Colleges

Building physics contribute decisively to humane and environmentally friendly building and make us realise the finiteness of resources. In the last decade, building physics evolved into an important discipline at home and abroad. Building physical knowledge has become indispensable in design, planning, construction, use, demolition and recycling of buildings. Thus, building physics are an inherent part of the education of architects and civil engineers.

Building physics, however, may not be regarded in an isolated way concerning education, but in the context with other disciplines such as design, construction, building materials, technical completion and so on. Individual sections within building physics must not be regarded as separate fields, but only as a total context. Building physics is an integral part of building design and therefore cannot be replaced by "Experimental Physics" or "Physics". Design without building physical knowledge will lead to bad or defective planning, where negative consequences become obvious not only during construction, but also have severe effects later during the long-term use of the building. It is necessary to integrate building physics in the design process from the very beginning, to meet the requirements on the building, but also to avoid economic and ecological disadvantages.

Building physics comprise the phenomena of heat (energy), moisture, sound, fire and light, occurring, from case to case, in the interior of rooms, in building components or in the environment of buildings, i.e. in urban surroundings (climatic effects). The importance of the individual sections will be clarified by the following description:

Heat

Energy saving is becoming more and more important and determining the technical construction of buildings considerably. It is indispensable for architects and civil engineers to master the calculation, planning and realisation of necessary measures for thermal insulation in buildings. Low energy houses require first of all a consequent integration of all building physical concerns. Thermal insulation in connection with moisture protection creates comfortable and hygienic living conditions. It will be essential for the future to give priority not so much to protection but to the "management" of heat flows.

Tabulation of Building Physical Sections:

Section Heat

	Minimum Teachings	in (%)	
		architects	building engineers
1.	**Aim** hygiene (physiological foundations), protection of the construction (thermal load), energy savings (precautions, economic efficiency), ecological damage, other climatic regions	15	10
2.	**Fundamental Terms** fundamentals of heat conduction, thermal convection and heat radiation (short wave and long wave), thermal properties of building materials (thermal conductivity, specific heat capacity, density, radiative physical values), thermal characteristics (thermal resistance, thermal transmittance of mono- or multi-layer building components	10	5
3.	**Thermal Bridges** heat losses and characteristics, indoor surface temperatures and characteristics, thermal and hygrical effects	10	15
4.	**Ventilation** ventilation, infiltration, ventilation concepts, tightness concepts	10	5
5.	**Heat Balance** building components balance (temperature calculations in case of interaction of radiation and convection in transparent and opaque building components and curtain walls), room balance	15	10
6.	**Non-Steady State Thermal Behaviour of Buildings** non-steady state heat transfer in building components, mechanism of heat storage, non-steady state heating and overheating effects, passive solar energy utilization by opaque and transparent building components, sun spaces made of glass, thermal insulation in summer (façade design, solar protection measures, interior building components, ventilation in summer)	15	20
7.	**Measures for Saving Heating and Cooling Energy** structural measures to reduce heat losses, energy-saving concepts, improvement of thermal insulation in old and new buildings, optimised thermal insulation with regard to costs, structural measures for the management of solar energy, system technology, balance of buildings, measures for the reduction of costs in existing residential and commercial buildings	15	15
8.	**Thermal Load of Building Components** thermal stresses and deformations thermal damage and remedies	5	15
9.	**Planning Tools** standardised methods computer-aided methods	5	5
	Sum	100	100

Moisture and Humidity

There are only a few loads, which are as intensive on a building as well as dangerous for the function and the substance as it is water. Problems of sealing and moisture protection against all phases of water penetration as liquid or vapour from outside, inside, below or in a cross section must be handled by architects and civil engineers in every detail of performance.

Sound

People want to live in quiet surroundings. Noise is evolving into a scourge for mankind in our modern high-tech society. Sound insulation in urban planning, between buildings and traffic spaces, is one of the most important measures of environmental protection. Architects and civil engineers must be able to integrate considerations on sound insulation in the design and planning as well as in the realisation of projects. Room acoustic design is essential for rooms with special requirements for the intelligibility of speech and music.

Fire

The protection of life and health, the protection of property and material assets - billions in assets are lost annually due to fire - demand from architects and civil engineers the knowledge of preventive structural fire protection and of the valid rules and regulations for fire protection as well as the structural implementation in design, planning and realisation.

Section Moisture

	Minimum Teachings	in (%)	
		architects	civil engineers
1.	**Aim** physiological effect of moisture, importance of moisture in architecture and civil engineering	10	5
2.	**Fundamental Terms** relative air humidity, water vapour content in the air, measurement of water vapour, characteristic water content of building materials, water vapour partial pressure, dew temperature, diffusion resistance, transport of liquid, water sorption	20	10
3.	**Moisture Storage** sorption and capillary condensation, moisture storage function, hygrical characterisation of pores, hygroscopical balance	10	20
4.	**Moisture Transport** moisture transport by diffusion, capillary suction and air flow, steady state and non-steady state moisture transport, other mechanisms for the transport of moisture	151	20
5.	**Hygrical Load of Building Components** swelling and shrinking of building materials, hygrical dilatation and bending of multi-layer structures, selection of building materials under severe impact of moisture	15	20
6.	**Moisture Protection in Buildings** protection against driving rain on horizontal, inclined and vertical areas, protection against condensation or domestic hot water, protection against water in the soil, measures against moisture damage in new buildings	25	20
7.	**Planning Tools** standardised methods (Glaser method) computer simulations	5	5
	Sum	100	100

Light

Daylight and sunshine are essential for the mental and physical human well-being. Besides aspects of energy savings and environmental noise, the design of windows and façades is becoming more and more important for the planning of buildings, even with regard to natural lighting and solar radiation. Daylight and artificial light must complement one another. A perfect lighting planning harmonises daylight and artificial light in a way, that - in compliance with lighting requirements - the operating hours for artificial light are minimised. Moreover, the functional and aesthetic effect of light during the day as well as during the night must be taken into consideration.

Section Sound

	Minimum Teachings	in (%)	
		architects	civil engineers
1.	**Aim** environmental noise immissions, aural perceptions, noise control	5	5
2.	**Fundamental Terms** sound field characteristics, wave propagation, perception and measurement of sound, calculations with sound levels	10	10
3.	**Room Acoustics** sound absorption and sound reflection, definition and calculation, absorber types, reverberation time, principles of room acoustic planning, sound control, echoic criteria, room geometry	25	10

Climate (Urban Building Physics)

With an always denser urbanisation, processes outside of buildings are gaining in importance. We are no longer satisfied with the changes resulting from an environment with high-density housing. We are worried about the climatic deterioration and noise propagation in the nearby environment of our homes. If urbanisation is growing denser, primarily in Third World countries, the emissions of megalopolises will have to be reduced. This is the only way to achieve a regional climate management. There is an interdependency between buildings and climate: There are climatic changes caused by agglomerations of buildings on the one hand, and on the other hand, buildings must be adjusted to the climatic conditions at the location (climate-adjusted building).

Besides conveying a basic building physical knowledge, practical training must be emphasized. The tabulation of building physical teachings gives a specification, which contents are to be taught and under which expenditure of time. It is to mention in this context that until now building physics were mostly not allowed the necessary time in the conditions for study and examinations. Therefore, we ask everybody concerned in deciding on conditions for study and examinations to guarantee the necessary time of at least 10 hours per week and semester for building physical teachings.

This memorandum for building physics is the third revised version after those version of 1979 and 1987. This memorandum is acknowledged by the members of the Permanent Conference of University Professors of Building Physics:

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Section Sound to be continued

	Minimum Teachings	in (%)	
		architects	civil engineers
4.	**Airborne Sound Insulation** sound reduction coefficient and parameters derived from measurement, mono-layer building components, influence of area-related mass, stiffness, coincidence effect, two- or multi-layer building components, resonance, flanking transmission, resulting sound insulation, measures for airborne sound insulation	20	20
5.	**Impact Sound Insulation** impact sound level, impact sound transmission, impact sound insulation of characteristic building components (fireproof floors, timber ceilings, stairs), measures for impact sound reduction	10	15
6.	**Flanking Sound and Vibration Attenuation** water installations and technical systems, flanking sound attenuation and vibration insulation	15	20
7.	**Environmental Noise Control** characteristic sound levels (operational noise, traffic noise, aircraft noise, noise immissions from leisure time facilities), sound radiation, punctual sources, linear sources, areal sources, sound propagation in the open air and in urban areas, sound shields	10	10
8.	**Planning Tools, Measuring Methods** standardised methods sound field simulations	5	10
	Sum	100	100

Section Fire

	Minimum Teachings	in (%)	
		architects	civil engineers
1.	**Aim** protection of life and health, protection of assets	5	5
2.	**Fire Protection Fundamentals** emergence of fire, fire load, ventilation, course and spread of fire, fire fighting	10	10
3.	**Fire Behaviour and Smoke Emission of Building Materials** concrete, mortar, plaster, bricks, metals, glass, timber, plastics, textiles, thermal insulation materials	20	20

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Section Fire to be continued

	Minimum Teachings	in (%) architects	in (%) civil engineers
4.	**Behaviour of Building Components and Dimensioning** concrete building components, heating processes and fire water effects, courses of temperature, stress peaks, calculation methods, fire behaviour of slabs, timber, pillars, walls and tension anchors, design features to increase fire resistance, dimensioning of building components specific problems of fireproof constructions (continuity, openings, joints, consoles, building components in the constructional context), masonry, steel building components (heating processes, dimensioning, direct/indirect protection), timber components fire behaviour of timber, dimensioning of timber constructions, measures to increase the fire resistance of timber building parts, composite building parts	20	30
5.	**Pipes, Stacks, Tubes, Ducts** spread of smoke, constructional principles	10	10
6.	**Requirement to Design Features and Equivalent Fire Loads, Rescue Provisions**	35	25

Section Light

	Minimum Teachings	in (%) architects	in (%) civil engineers
1.	**Aim** lighting provision lighting design safety, orientation traffic control	10	10
2	**Fundamentals**		
2.1.	**Physical Fundamentals** sunlight and sky, position of the sun (height, azimuth, declination, angle of incidence), time of solar radiation (sun rise, sun set, seasons, times of a day, presumable solar radiation), light-relevant fundamental terms (luminous flux, lighting strength, intensity of light, luminance), light dispersion, fundamental terms of radiation (intensity, wave length, long-wave and short-wave UV-shares), types of radiation (direct, diffuse radiation, clear and overcast sky, degree of clouds), radiation physical characteristics of building components (absorption, reflection, transmission),	15	15
2.2	**Physiological Fundamentals** visible physiology, light sensitivity, perception and signalling effect of colours, requirements of perfect vision	10	10

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Section Benchmarks for Weighting in (%)

section	architects	civil engineers
heat	30	30
moisture	10	20
sound	20	10
fire	10	20
lighting	15	5
climate	15	15
sum	100	100

Section Light (to be continued)

	Minimum Teachings	in (%) architects	in (%) civil engineers
3.	**Daylight** daylight in the open air and indoors, daylight ratio, distribution of lighting intensity	20	20
4.	**Artificial Lighting** daylight complementary lighting, operating hours, artificial light sources (lamps, tubes, radiators), electrical performance, efficiency, total energy balance	15	15
5.	**Lighting Design** façade design, colouring, light control systems, glare protection	20	15
6.	**Planning Tools** standardised methods computer-aided methods simulations	10	15
	Sum	100	100

Section Climate (Urban Building Physics)

	Minimum Teachings	in (%) architects	in (%) civil engineers
1.	**Aim** climatic changes caused by urbanisation, climate management by means of buildings	10	10
2.	**Climatological Fundamentals** air temperature (seasonal and day-time fluctuations), air humidity (seasonal and day-time fluctuations), radiation intensity, including attenuation caused by cloudiness according to the seasons or time of day, wind (frequency of velocity and direction), seasonal driving rain	25	20
3.	**Heat and Material Balance in the Open Air and in Urban Areas** energy budget of natural areas (meadows, forests, lakes), impacts of development on evaporation, albedo, heat and water storage (urban heat islands and green spaces), pollutant emissions from buildings and traffic (Sick City Sydrome), pollution of waters, inversion weather conditions	15	20
4.	**Building Aero-Dynamics** wind profile over open air and urban areas, distribution of velocity and pressure in the boundary layers of buildings, gusts of wind, wind barriers (fences, forest aisles etc.), flows through buildings, residential and urban areas	20	25
5.	**Climatic Effects of Structural Measures** energy saving by urban area management, supply of fresh air in urban districts, generation of barriers, micro-climate design, urban climate hygiene, especially in metropolises	20	20
6.	**Climate-Adjusted Construction** fundamental principles of climate-adjusted construction in different climatic zones on earth, performance of climate-adjusted building in design and construction	10	5
	Sum	100	100