THERMALLY ACTIVE CONSTRUCTIONS*

by

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It is needless to emphasize the relation between energetics and architecture and its importance: it is well known that the field under the competency of Ministry of Building and Urban Development has a greater share from the energy consumption than has that of any other ministry. Thus, in the field of energetics, architecture influences fundamentally the social-economic environment and, because of the longevity of the buildings, it has long been determinant for the quantitative growth and structural composition of the energy consumption. The general actualness of the problem needs no support and the present actualness arises from the fact that Prof. Gábor did not only launch this scope in his Institute but has been an active developer as proved by our book "Energetics in Architecture" now in press.

Let us consider first whether satisfaction of energetic requirements is a new problem in architectural design or not.

The problem is not a new one in that thermal dimensioning has been part of the design, with the primary aim, however, of substance protection.

On the other hand, the design of an up-to-date building structure considered in itself, made of new materials and according to a new design approach, cannot always rely on experiences obtained on traditional structures.

Energetic dimensioning does not deal with a single building structure any more but with the whole building, that is not simply the sum of parts but a different, sophisticated and qualitatively other thing: an energetic system.

This energetic system can only be handled by systems approach.

These are popular, fashionable terms but the involved notions cannot be disregarded even risking to be charged of fashionableness. Of course, there is no question of some superdiscipline overriding specialities, only of the complex interrelation and interaction between the building, the incorporated domestic equipment and the involved processes and activities. Thus, no energetically optimum wall, floor or heating system exists in itself, detached, out of its context. The only correct procedure is pondering their role in the building

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as a whole, their relation to other components. This is by no means easy, namely often contradictory, almost antagonistic requirements are faced.

An evident example is the problem of the vitreous ratio of the façade: for a high vitreous ratio the wanted thermal insulation and air tightness are difficult to provide for — at the same time the lighting energy demand decreases and the radiating heat gain reduces the heating power demand; however just the great radiating heat gain presents difficulties in summer, etc., what is more, all these problems differ between hall-like buildings and those consisting of cells; in latter case even the number of storeys, the storey in question and the orientation of the façade matter. And if these energetic problems had been solved satisfactorily, one may wonder if this solution satisfies the other demands arising on different system levels — how it is related to the building or structural system, to systems on human and social level.

The requirement to consider the building as a unified energetic system causes certain principial problems in itself because industrialized building involves mass production of system components and units not known when produced, where, in what building, in what disposition, inside what a "system" to be built in.

In this connection two fundamental problems arise. First, whether it is possible to assemble an energetically correct or optimum building from precast units or more exactly, from a given unit assortment.

Second, whether units or an assortment of units could be developed without knowing the actual building or the actual disposition so that the possibility to erect energetically correct or optimum buildings arises.

The obvious answer to the first question is that under the given restricting conditions, the possibly best — the least wrong — solution can be produced of any assortment.

Namely several architectural means of an energetic importance similar to that of the thermal insulation or the air sealing of the given precast units belong in the "range of activity" of the designing architect.

As an example: in the heating energy consumption of a nowadays typical, medium-rise panel block of flats the same energy saving can be achieved with a better design of wind shields and staircase landings as by doubling the thickness of wall slab thermal insulation. Other, mostly known factors could be cited, as e.g. orientation, mass moulding, circulation spaces inside the building, etc., but let us get back to the precast units.

The second question a priori concerns the energetic optimization of the building rather than of the units, a problem still made complexer by the use of the units in rather different positions in a wide range of buildings.

As the energy transfer in the building is determined by the coherent and interacting system of the constituting units, different thermal requirements are made for the units — otherwise functionally and architecturally of identical purpose, — depending on their disposition. The more varied the possibilities of use of a unit, the less its thermal function after built in can be preassessed. Obviously it would not be sensible and economical to develop every unit with the highest thermal parameters, sure enough, also creation of idle capacity consumes material and energy.

Wider possibilities, and if properly applied, energetically better buildings are offered by the creation of thermal alternatives within each unit group of identical function keeping structure, dimensions, joints, architectural design constant. Increase of the number of alternatives is a better approach to an optimum for a wide range of buildings, especially in view of the numerous combinations of thermally different units to be developed for a building.

Thermal alternatives can often be realized by simple means, e.g. by varying the thickness of the thermal insulation core of a slab, or the quality or glazing of the built-in window or door etc.

Development of an energetically satisfactory unit assortment is beyond doubt also a product planning task. Remind, however, that thermal demands to units, precast products can only be formulated on the basis of testing the energy balance of the buildings, optimization can issue solely from the building as a whole.

Now let me drop a few words on the role of time, to be examined from two aspects: the change of the social-economic environment during the service life of the building; and the time dependence of meteorological factors influencing the energy consumption.

To the first problem: The rate of change of the social-economic environment during the extended service lives of buildings is difficult to extrapolate, however the trend is unambiguous. Because of the limited hydrocarbon reserves resulting in further increase of energy costs the building will face increased energetic demands. It is to be expected, even to be foreseen that within the lifetimes of newly erected buildings, the diminished hydrocarbon reserves exclude anything but fuel oil or chemical uses, their direct burning up will become irrational. Therefore the present, mostly hydrocarbon-based energy supply of the buildings has to be reversed or returned to other carriers. This change involves, however, also architectural and building structural requirements to be prepared for.

With the other problem, change in time of the meteorological factors the trouble is that under different outer conditions, ever a different component of the energy transfer in the building prevails. The intensities and proportions of energy flows resulting from the temperature, the wind, the radiation change along the year and even during the heating season. Thus, energetic design of a building or a unit must not examine a single condition, but the analysis has to be extended to different operating conditions, taking also their frequencies into account, or in addition to units with timely constant properties, building structures accommodating changes of boundary conditions or even taking an active part in energy transfer have to be developed.

As examples for structural solutions accommodating the changes of boundary conditions, the mobile sun shields and the gravity ventilated wall structures can be mentioned.

Building structures active in energy transfer can be considered at the same time as parts of the heating and ventilating system: integrity of the building and the heating system is manifest in this case in structural and functional integration.

Building structures active in energy transfer may have different energetic functions: they may contain the heater or, developed as double shells and using the otherwise wasted energy flows, could create a superior, fictive environment, practically enveloping the house.

From the point of view of the predictable change of the energy carriers special functions are to "collect" solar energy as well as thermostated or controllable energy storage and/or emission.

As concerns architectural function, active building structures may be walls, floors, roofs, doors and windows: there is a quite considerable number of already tested varieties.

It is not easy to draw a line between active and passive part in energy transfer: as every classification, this too contains subjective elements. For instance, also "ordinary" windows collect important qualities of solar energy reducing the heating energy demand of the room — this is a passive part because the collected energy is utilized only if the heating equipment is controlled to follow sensitively the changing demands. Also a sun shield absorbs much of solar energy to be transmitted to the environment — this is also a passive part; but the energy absorbed by a shield inserted between the panes of a so-called ventilated window as an element of the ventilating duct net is available to controlled "disposal" and utilization — an example for the active part. Another example for the active part, the ventilated window in winter, where the dismissed air circulates between the window panes under control, practically creates an artificial environment for the room because from the aspect of room heat loss, now the "outer" air temperature is that of the air circulating between the panes.

Many other examples for active structures are known.

Let me present somewhat in detail the example of walls or floors complete with phase-change heat storage charges. Its essential is to accommodate suitable vessels in the walls containing chemicals — heat storage charges — able to absorb or to emit a considerable quantity of heat through solid-liquid phase change at a given temperature.

The structure can be developed as a storage heater, with periodical power supply such as off-peak power, or alternative energy like solar heat. The system might be used to warm up ventilating air, and the surfacing of the wall structure combined with a solar system can be developed to "collect" energy.

The active building structures not only exemplify structural and functional integration but also satisfy other energetic requirements for building structures.

The first is the quoted requirement to develop a suitable assortment of different thermal alternatives with the same dimensions, joints and architectural design.

To satisfy this demand in case of active structures even a suitable adjustment of some operational parameter may be of use, e.g., for a ventilated window, the mass flow of air between the panes, for walls with heat storage changes the quantity and quality of the heat storage charge in the given storage room, etc., thus, thermal alternatives do not impose structural or dimensional modifications.

Active structures accommodate meteorological changes, namely their connection with the heating system mostly permits to adjust or control one or other of the parameters (e.g. air mass flow or wattage). They can also cope with requirements arising from the change in energy carriers inasmuch as — besides of a low power consumption — they can be operated either with electric power or with energy from alternative sources.

Several examples for active structures may be found, not only in some experimental buildings, but in many individual, outstanding establishments.

It can be taken for granted that after drawing conclusions from their operation and maturing of structural solutions these structures will also appear in industrialized mass construction and just because they are suitable to satisfy demands differentiated in space and time, they will become — of course not the only but a very important — asset to meet energetic requirements for buildings.

Summary

An important problem in industrialized building with a bearing on energetics is the placing of a high number of precast units of identical features under different conditions. at a spacely and timely changing part in the energy transfer of buildings. The unit assortment can be somewhat increased during prefabrication from the aspect of thermal parameters but a better method of adaptation to spacely and timely changing requirements is to develop thermally controllable or self-adjusting units. The realization of this principle results in the integration of wall structures and heating-cooling systems.

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