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ROMANIAN CLIMATE DATA IMPACT ON PASSIVE BUILDINGS DESIGN

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Conceptul de clădire pasivă este temeinic studiat în Europa centrală şi de vest, unde a fost inițial adoptat. Există, totuşi, o cunoaştere limitată a aplicabilității conceptului atunci când este folosit la alte latitudini geografice şi climate, în Europa estică şi de sud. Ar asigura soluțiile empirice de proiectare constructivă existente îndeplinirea cerințelor standardului clădirilor pasive în aceste regiuni? Lucrarea prezintă şi compară performanțele energetice ale unei clădiri pasive imaginar plasată în diverse zone climatice: în Germania şi, respectiv, România. Sunt folosite date constructive ale clădirii pasive cu destinație administrativă AMVIC (din localitatea Bragadiru, lângă Bucureşti) şi date de climat, pentru un total de douazeci şi două de localități în cele două țări.

The passive house (PH) concept is thoroughly studied in Central and Western Europe, where initially adopted. There is, however, rather little knowledge about the applicability of the current PH concept when used at other geographical latitudes and climates, in Eastern or Southern Europe. Would the existing empirical construction design solutions ensure, in these regions, the fulfilment of PH standard requirements? The paper presents and compares the energetic performances of the same PH as if built in various climatic zones, in Germany and Romania, respectively. Constructive data of the non-residential AMVIC PH (from Bragadiru, near Bucharest) are used and also climate data for a total of twenty-two towns in the two countries.

Keywords: passive house (PH), climatic zones, building heating demand

1. Passive house energetic requirements and European climate

Passive houses (PH) have to reach, primarily, a target **heating energy demand** less than 15 kWh/(m^2.y) and a **total primary energy demand** less than 120 kWh/(m^2 y), apart from other functional requirements [1]. This was possible applying empirical design solutions, first in Germany, then these were considered as appropriate for Central and West Europe (generally, between 40 and 60° N latitude). When later analyzed, in the colder climate of North Europe, design solutions with larger insulations and bigger internal heat gain proved necessary

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[2]. At lower latitudes, with higher level of solar irradiation during the heating season, more relaxed ones were considered [3]. German PH design solutions (insulated wall structures, super insulated frames-triple glazed windows, etc.) were promoted to East and South Europe, and more specific to Romania. Are they to be applied unchanged? To answer, comparing climate data from Germany and Romania seemed to be a good beginning [4], but proved to be inadequate without a knowledge of the thermal properties of envelope components. Now we continue the previous work, comparing energetic demands of a PH [5], as if imaginarily « re-located » in towns of the two countries where different range-values of cold temperatures and different cold clime distributions zones, Fig.1, can be seen.

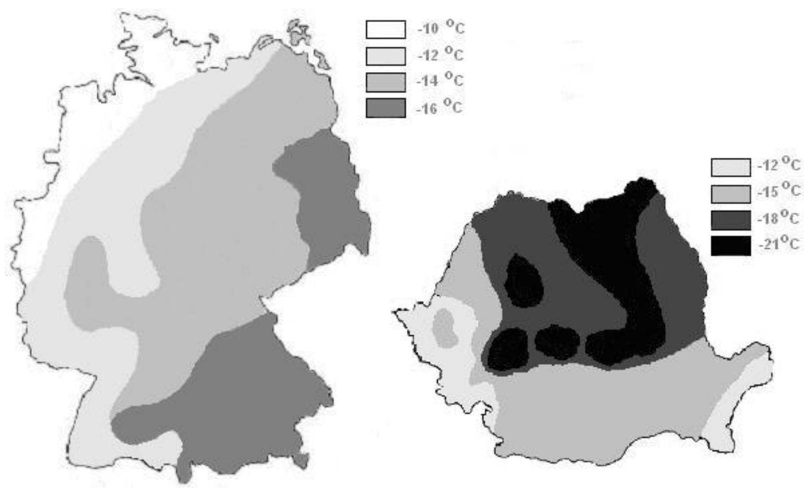

Fig. 1A, B: Climate zones - conventional temperatures used in computing the heating demand in Germany (A) and Romania (B)

Passive House Planning Package (PHPP), software developed by Passive House Institute Darmstadt is used. One enters thermal properties for envelope, windows, roof and basement and internal heat gains from [5] (human presence, domestic appliances), climatic data from [8] (monthly temperature and solar irradiation on different oriented N, S, W and E vertical walls); among results: the specific heating energy demand and the specific total primary energy demand. The variation of these energetic performances is studied and compared between the various towns/climatic zones of Romania and between Germany and Romania.

2. PH energetic performance variation in European climate

The same number of 11 towns was chosen, in Romania, from [6] and in Germany, from [7], together with some other specific data and put in Table 1. They are almost evenly distributed on the two territories, between the limits of longitude and latitude and also considered representative for the potential development of PH. Towns in Table 1 are differently indexed (for Romania - by number of heating degree-days; for Germany- by latitude). One retrieves climate zones from Fig. 1 (defined as borders of conventional temperatures used, generally before 2008 in each country, in the heating demand calculus) and the necessary heating degree-days, in the same range (from -12ºC exterior to 20ºC interior) for the two countries, according to [6] respectively [7]. These reference data are followed, in each last column, by the specific heating demand / total primary energy demand, computed with PHPP, as previously described.

Table 1

Reference and computed data for localities in Romania and Germany

Romania / Town	Lat. (^{0}N)	Clime zone (^{0}C) / Heating degree-days	Heating demand / Tot. primary energy (kWh/m^2.y)	Germany / Town	Lat. (^{0}N)	Clime zone (^{0}C) / Heating degree-days	Heating demand / Tot. primary energy (kWh/m^2.y)
Iasi	47.16	-18 / 3510	11 / 85	Hamburg	53.55	-12 / 3413	10 / 85
Oradea	47.06	-15 / 3150	10 / 84	Berlin	52.51	-14 / 3310	12 / 86
Cluj	46.76	-18 / 3730	10 / 84	Hannover	52.36	-12 / 3342	10 / 85
Bacau	46.56	-18 / 3630	10 / 84	Dortmund	51.51	-12 / n.a.	9 / 84
Timisoara	45.74	-15 / 3180	8 / 83	Leipzig	51.30	-12 / 3435	12 / 86
Brasov	45.63	-21 / 4030	8 / 82	Dresden	51.10	-12 / 3485	12 / 86
Galati	45.45	-15 / 3190	8 / 82	Köln	50.93	-12 / n.a.	8 / 84
Pitesti	44.85	-15 / 3420	7 / 81	Frankfurt/M	50.11	-12 / 3098	9 / 84
Bucharest	44.43	-15 / 3170	7 / 81	Darmstadt	49.87	-12 / n.a.	9 / 84
Craiova	44.31	-15 / 3170	6 / 81	Stutgart	48.76	-14 / 3463	8 / 84
Constanta	44.18	-12 / 2840	7 / 81	Munchen	48.70	-16 / 3543	10 / 85

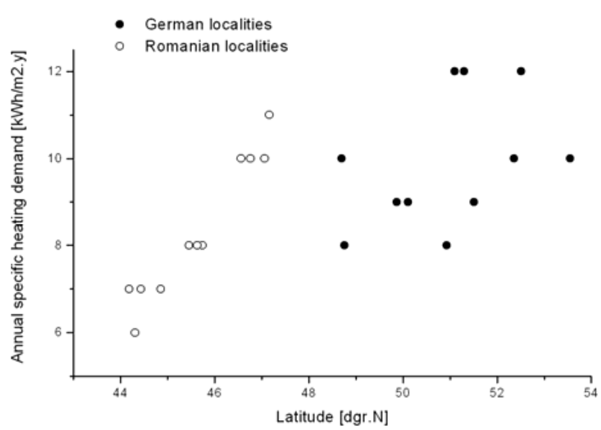

Fig. 2: Dependence of heating demand on latitude for various sites in Romania and Germany

Comparing the heating demand variation from the corresponding last columns of each country, in Table 1, one remarks a clear linear dependence on latitude, in Romania, compared to an apparent none correlation, in Germany (Fig.

2). In moderate climate zones from Germany and Romania, for the same PH structure, the heating demand is more reduced in Romania. Also, various towns of Romania, situated in the same climate zone (Fig.1B, zone of -15^{0}C), but at different latitudes, exhibit a grater variation of the heating demand (Table 1, Oradea: 10 kWh/m^2.y / Craiova: 6 kWh/m^2.y equals 1.66 for Δ lat. N = 2,75^0) while, comparatively in Germany, for similarly situated localities (Fig. 1A, zone of -14^{0}C), the variation interval of the heating demand is more restraint even if the latitude difference is higher (Table 1, Berlin: 12 kWh/m^2.y / Stuttgart: 8 kWh/m^2.y equals 1.5 for Δ lat. N = 3,75^0). Due to the limitation of the town number in each country (11), the range limits of the heating demand are not represented, mainly in Germany. This is because we focused mostly on Romanian climate variation impact on PH constructive design solutions.

4. Conclusions

Comparing the energetic performance variation function of climate data and latitude (Table 1 and Fig.2), one see that, for the same PH constructive structure, the heating demand, computed by means of PHPP, is in Romania latitude dependent and more reduced comparative to Germany. Towns, situated in the same climate zone at different latitudes, exhibit a variation of the specific heating demand higher in Romania relative to Germany, where the variation range is smaller but with larger absolute values. On a large extent of the Romanian territory (Fig.1B), under 45^0 latitude N, with higher solar irradiation during the heating season, the heating demand (of 6-7 kWh/m^2.y) is lower compared to central Germany (8-12 kWh/m^2.y). So, PH design solutions from Germany may be more relaxed; explicitly, as example, exterior insulation depths of 20 mm Polystyrene + 6.3mm Neopor® of all PH building concrete wall panels, as everywhere used for the heating demand estimation in Table 1, may be reduced. This could lead to a reduction of PH initial costs.

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