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HEAT TRANSFER PERFORMANCE UNIFORMITY FACTOR FOR THE BASEMENT FLOOR MADE OF BRICK VAULTS IN RESIDENTIAL HISTORIC BUILDINGS

Abstract: *The paper exposes the calculation of Heat transfer performance uniformity factorfor the basement floor made of brick vaults in residential historic buildings. It was determined that the temperature pattern on the floor surface of the premise could be characterized as uniform one. Heat transfer performance uniformity factor for the considered basement floor design can be ignored during the thermotechnical calculations. Thermal resistance calculation is performed for the overlap structure with the smallest thickness*

Key words: historic building, basement floor, energy efficient, reconstruction, heat transfer performance uniformity factor

Problem statement. Energy efficient reconstruction of historic buildings is usually accompanied by a heat insulation of the building envelope. If the basement is unheated, theproblemof the basement floor insulation comes up (in the case of proven need). The paper exposesthe determination thermotechnical uniformity coefficient for the basement floor over steel beams with brick vaults filling.

Analysis of the recent researches. The result of this study can be used for designing the insulation of basement floors in historic buildings [1–4].

Article purpose is heat transfer performance uniformity factor for the basement floor made of brick vaults in residential historic buildings.

The main part. Basement floor structures. In residential buildings built in the late XIX – early XX centuries, the most

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common basement floor structure was the slab over steel beams (Fig.1) [5]. Filling between the beams can consist of the following structures (Fig. 2, 3) [6, 7]:

– of the brick vaults with a thickness of 1/4 – 1/2 bricks (Fig.2,a);

– concrete (Fig. 2, b) or reinforced concrete vaults with a 7-8 cmthickness;

– of flat reinforced concrete fillings with haunches (Fig.2, c), and without (Fig.2, d).

a)

b)

Fig.1. a), b) Floor slab in the form of vaults over the steel beams [5]

The first of the abovementioned types of floor structures is one of a frequentoccurrence [5]. In order to analyze the temperature field,

the floor structure described in [7] (Fig.3). Spacing between the beams is assumed as 1.2 m.
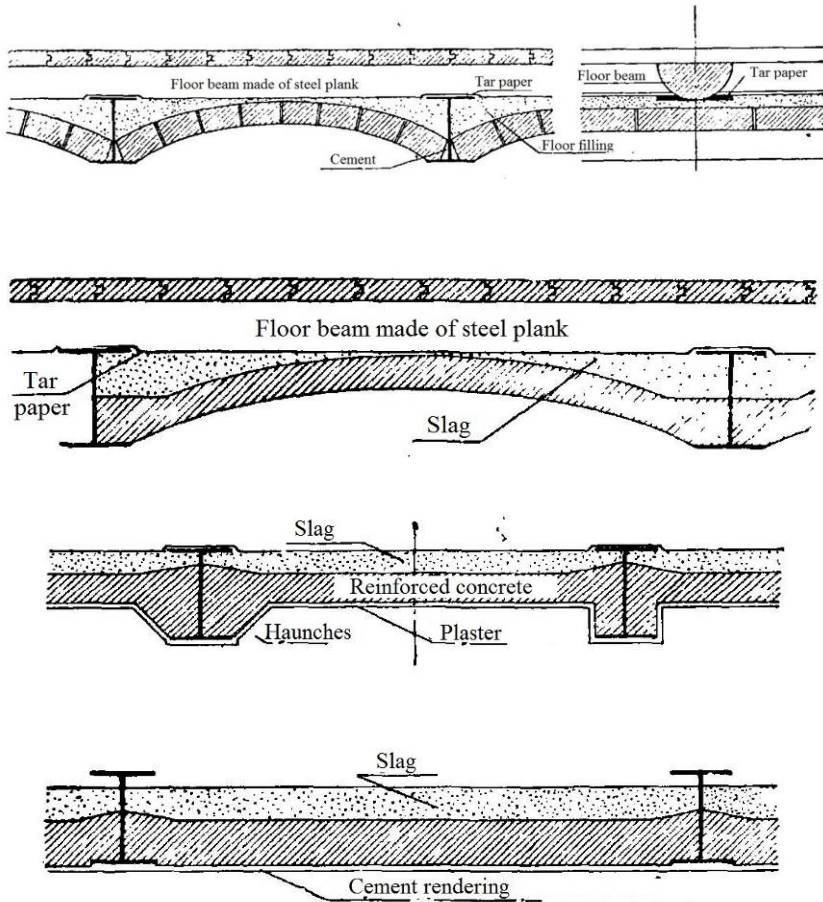
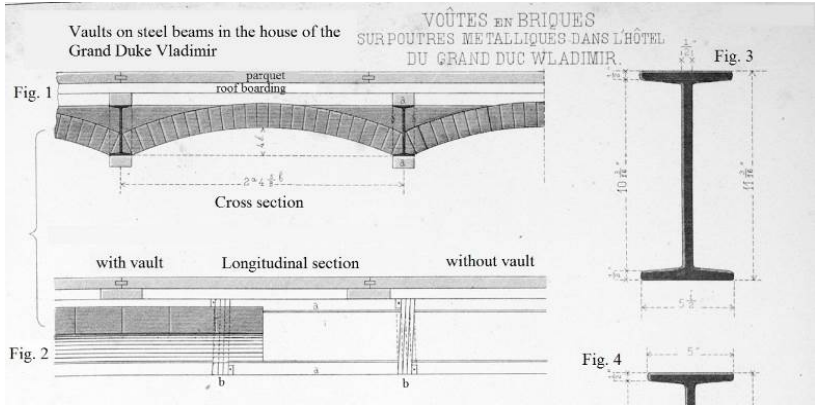*Fig.2. Basement floor structures [6].*

Fig.3. Vaults over the steel beams [7]

Determine the heat transfer performance uniformity factor for the basement floor.

In order to determine the heat transfer performance uniformity factor temperature field calculation was performed as well as the calculation of heat flows in floor structure according to the "ELCUT" programfor the reference temperature of the internal air of 20° C and the air temperature in the cellar2° C (Fig.4).

Heat transfer performance uniformity factor r is a dimensionless index, numerically equal to the ratio of heat flow through a fragment of inhomogeneous building envelope structure to the heat flow through the conventional homogeneous envelope structure designs with the same surface area as that of the fragment.

As a result of the calculation the value of the heat transfer performance uniformity factor the building envelope was determined, taking into account the impact of beams, $-r = 1$. As a conventional homogeneous building envelope structure the thinnest floor structure between the beams is considered.

The specific thermal resistance of the basement floor:

$$R_o^{sp} = R_o \cdot r = R_o, \text{ m}^2 \cdot \text{°C/W},$$ (1)

where R_o is the thermal resistance of homogeneous building envelope structure which was determined for the thinnest floor structure, $m^2 \cdot °C/W$.

It should also be noted that the considered basement floor structure above provides uniform temperature field on the floor surface in the room (Fig.4, a).
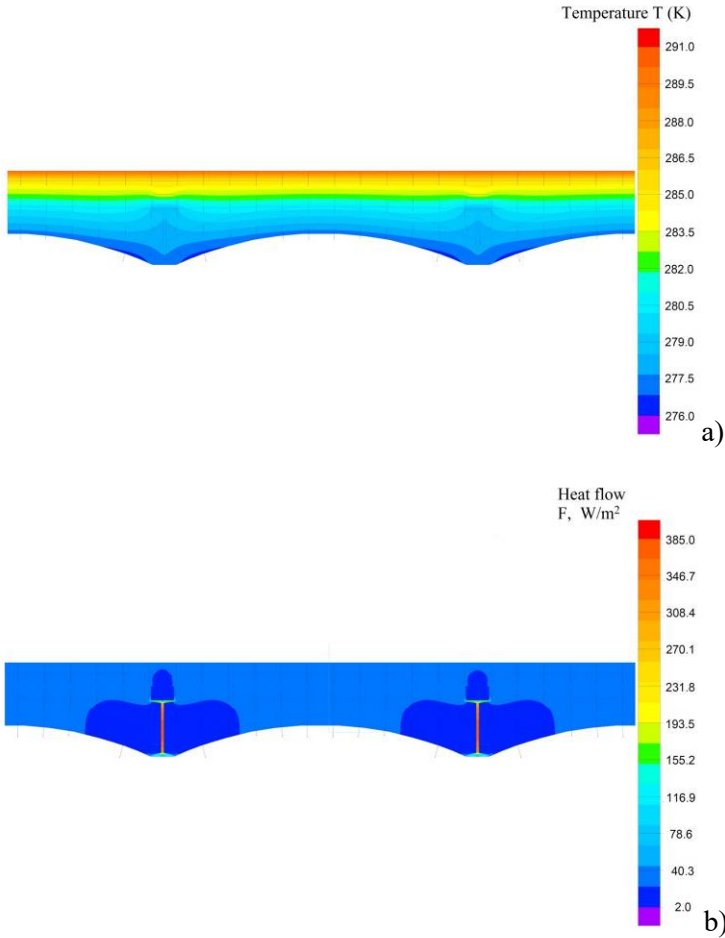
Fig.4. Temperature field (a) and distribution of heat flows (b) in the structure of the attic floor

Conclusions. 1. The heat transfer performance uniformity factor for the basement floor made of brick vaults in residential historic buildings was determined. The heat transfer performance uniformity factor for the considered basement floor structureis assumed as 1 for the thermal calculation. Calculation of floor thermal resistance is performed for the structure type with the smallest thickness.

2. It wasdetermined that the temperature field on the floor surface in the premises is homogeneous.

References

1. Martínez-Molina Antonio, Tort-Ausina Isabel, Cho Soolyeon, Vivancos José-Luis. Energy efficiency and thermal comfort in historic buildings. *Renewable and Sustainable Energy Reviews*, 2016. Vol. 61. P. 70–85

2. Cornaro Cristina, Puggioni Valerio Adoo, Strollo Rodolfo Maria. Dynamic simulation and on-site measurements for energy retrofit of complex historic buildings: Villa Mondragone case study. *Journal of Building Engineering*, 2016. Vol. 6, P. 17–28

3. Julien Berger, Helcio R. B. Orlande, Nathan Mendes, Sihem Guernouti, Bayesian inference for estimating thermal properties of a historic building wall. *Building and Environment*, 2016. Vol. 106, P. 327–339

4. M. Harrestrup, S. Svendsen, Full-scale test of an old heritage multi-storey building undergoing energy retrofitting with focus on internal insulation and moisture. *Building and Environment*, 2015. Vol. 85, P. 123–133

5. Laptev E. A., Ulybin A. V. Osobennosti obsledovaniya perekrytiy po stal'nym balkam s nakatom v vide svodikov. Obsledovanie zdaniy i sooruzheniy: problemy i puti ikh resheniya. *Materialy VI mezhdunarodnoy nauchno-prakticheskoy konferentsii* 15-16 oktyabrya 2015. S.Peterburg : Izd-vo Politekhn. un-ta, 2015. P. 95–105.

6. Tekhnicheskaya entsiklopediya [Pod red. L.K. Martensa]. Tom 17. Moscow : OGIZ RSFSR, 1932. 451 p.

7. Zodchiy: *Arkhitekturnyy i khudozhestvenno-tekhnicheskiy zhurnal, izdavaemyy S.-Peterburgskim obshchestvom arkhitektorov.* S.Peterburg, 1872, 11.

Анотація:

Мургул В. Коефіцієнт рівномірності теплопередачі для цегляних склепінь підвальних поверхів в житлових історичних будівлях.

Стаття показує розрахунок коефіцієнта рівномірності теплопередачі для цегляних склепінь підвальних поверхів в житлових історичних будівлях. Було встановлено, що температурний режим на поверхні перекриття можна охарактеризувати як рівномірний. Коефіцієнт рівномірності теплопередачі для даної конструкції підлоги підвалу може бути проігнорований під час теплотехнічних розрахунків. Розрахунок теплопередачі виконується для структури перекриття з найменшою товщиною. Коефіцієнт рівномірності теплопередачі для даної конструкції підлоги підвалу приймається як 1 для теплового розрахунку.

Ключові слова: історична будівля, цокольний поверх, енергоефективний, реконструкція, теплопередача Коефіцієнт рівномірності теплопередачі.

Аннотация:

Мургул В. Коэффициент равномерности теплопередачи для кирпичных сводов подвальных этажей в жилых исторических зданиях.

Статья показывает расчет коэффициента равномерности теплопередачи для кирпичных сводов подвальных этажей в жилых исторических зданиях. Было установлено, что температурный режим на поверхности перекрытия можно охарактеризовать как равномерный. Коэффициент равномерности теплопередачи для данной конструкции пола подвала может быть проигнорирован при теплотехнических расчетах. Расчет теплопередачи выполняется для структуры перекрытия с наименьшей толщиной. Коэффициент равномерности теплопередачи для данной конструкции пола подвала принимается как 1 для теплового расчета.

Ключевые слова: историческое здание, цокольный этаж, энергоэффективно, реконструкция, теплопередача, коэффициент равномерности теплопередачи