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Effect of Central and Linear Holes on Thermal Behavior Based on Babylonian Clay

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ABSTRACT

This article examined the effect of central and longitudinal vents on the thermal behavior of the slurry compound Mineral analyzes of the used clays were performed to find the composition of the components for the clay. It was thermal characterization, In a hot cylinder fashion. The thermal transfer analysis, thermal resistance, energy saving and density fraction were extracted in a practical way. This study is important to know the effect of internal gaps on thermal conductivity during the manufacturing process, From the extracted girls, it was found that the central openings dissipate heat and reduce the conductivity, and it is less compared to the longitudinal openings.

KEYWORDS

central holes, Clay composite, linear holes, Thermal conductivity, Thermal transmission coefficient, Thermal resistance.

INTRODUCTION

Energy policy prioritizes energy conservation in conjunction with the production of renewable energy sources. The strategy aims to cut energy demand by 12% by 2020 and 15% by 2030, as well as a portion of CO_2 emissions. In key industries, such as the construction industry, related energy efficiency action plans have already been initiated. According to the Energy Efficiency Council, buildings account for about 36% of total energy consumption (AMEE). Thermal insulation wrapper improves a significant deposition energy saving in this sense [1–3]. Kheiri [4] explores on three levels, the effect of thermal insulating its exterior building vertical slats: economic, environmental, and social. The findings indicate that investing in thermal insulation is advantageous for both environmental and economic reasons. As a result, the production of environmentally friendly and the use of environmentally friendly, high-efficiency construction materials the amount of energy required to cool and heat of indoor environment homes. The sustainable idea of building, which means of ensuring that sustainable development policies are implemented. According to Cork was interesting additive, according to a wide set of previously examined researches.

It blends building materials to produce lightweight composites that are thermally efficient [5–8]. its investigates the synthetic porosity a clay-cork composite's thermal behavior. using of entrained air in thermal insulation envelope is becoming increasingly common as a means of improving building thermal efficiency. Envelope elements including that air layer can still be included in existing structures. due to the various benefits that air layers can offer to building envelopes [9]. Glazed windows and façades [10], Trombe walls [11], and double-skin facades [12,13] are only a few examples. Simultaneously, several important papers on hollow and porous building materials have been published in recent years. The modulation of The effect of combined fluid flow and heat transfer in rigid building materials by Chu et al. [14]. Zhang et al. [15] Take a look at such a porous material exhaust insulation wall: a dynamic thermal efficiency and parametric analysis that can be permeated by air. Sutcu et al. [16] investigate how to improve the thermal efficiency for hollow clay made from paper. Many scientific publications [17–22] have also looked into porosity effect on porous materials' thermal efficiency.

The ability pores to increase the thermal efficiency of porous materials has been demonstrated. For the passive-house style, A hollow bricks structure [23] can also be used as construction material. A hollow's drying density and thermal conductivity clay-cork mixture are experimentally studied is presented in this paper. Clay was observed from two main viewpoints. X-Ray Diffraction and Florescence have been used to investigate the mineralogy properties of the two clay types The Angular Hot Plate technique is used in order to compute the thermal conductivity of sintered material. The numbers [6,24,25] would be used. The thermal transmission of an external walls built of There was a link among Benhmed hollow content, Bensmim hollow content, and modern clay tiles. factor and energy savings. The thermal resistance (R) of a 25 cm thick hollow material brick was measured and compared to the R a standard clay brick has same thickness. When artificial porosity is applied to a clay-cork composite, it produces a lightweight hollow material with substantially higher thermal efficiency than a hole-free clay-cork hybrid.

MATERIALS AND METHODS

Preparing Samples

A natural building material that is both inexpensive and plentiful. Humans have used and studied it throughout history. widely used, particularly in the fields. They used mineral from the Bable region during this project. victimisation X-Ray light, a qualitative Bable's research collected soil samples was performed. The findings are bestowed in Tables 1 . Bable clays have different mineral compositions was studied victimisation diffraction. completely Various crystals were discovered in soil samples that were studied are outlined during this manner. The potassium particle filling within layer areas of microstructure, that prevents the clay from swelling, confirms this result [12]. As a result, the clays studied had little plasticity, no shrinkage, with great forming. A fall into category compositions that could be used to make reddish, brown, or yellowish bricks [26–28]. Tables 1 demonstrate an overabundance of assumptions based on the findings. The presence of aluminum oxide ($Al2O3$) in the clays examined indicates the presence clay into soil. Furthermore, clay's high potassium oxide ($K2O$) content confirms that it is of the Illite form. Other components, like oxide ($Fe2O3$), cause this clay to be classified as ferruginous clay, that explains its red color [29]. quicklime (CaO) controls the Our clays' structure and rupture threshold, as well as their low content (0.08-3.16 percent by weight) helps us to identify them as non-calcareous clays[30]

Table 1. Chemical composition of Babl clay

Chemical component	Sio2	Al2o3	Fe2o3	Mgo	Tio2	other
Mass fraction (%)	62.3	17.4	11.2	1.2	0.6	8.2

Rockwool is a type of wool that is used to It was employed in order to verify and comprehend the findings of this study. On a Rockwool sample that had already been ready, the thermal conduction and bulk density were determined experimentally in this study, The ready Rockwool sample is shown in Figure (1).

Figure 1. View of the tested Rockwool sample

Solid and hollow composite of clay samples with 30 Babel clay and one central holes would rendered. The created holes are circular in shape and have a diameter 5 mm. As a control, a samples will be prepare. To explain and interpret the findings, will be examined hollow substance samples with holes in center , lengthy hole and solid clay. All samples are 30 mm in diameter as shown in Figures 2 and 3. used concentrated cork saturated with a clay hybrid during this study. Granular cork was poured into the used mold until it was fully finished. The spaces between the cork grains were then full of clay at a quantitative relation of 0.25 water to binder. All of the samples were placed in a very stove, and their lots were monitored on a daily basis till the full wet within the samples was removed. the quantity fraction of granular cork within granular cork was calculated exploitation the formula in eq. (1):

$$\rho = y\, \rho_{A} + (1-y)\, \rho_{B} \quad (1)$$

Where ρ, ρ_A, and ρ_B are the densities.

Figure 2. Babylon linear holes samples

Figure 3. Babylon central holes samples

Thermal Calculation

The imbalanced Hot cylinder procedure [6,24,25] will be used to calculate the heat conduction (ρ) of available samples in the steady-state regime. In based on Iso 6949 [34], the results state transmission problems [34] with even energy-saving [6] of Include in Nursing outer wall. The exterior wall will be built using either a traditional clay brick or a hollow material as a base, according to Eqs. 2 and 3

$$1/U = 1/h_i + e_k/\lambda + 1/h_e \quad (2)$$

$$E_{saving} = 100^* \{1 - \lambda_{hollow} / \lambda_{clay}\} \quad (3)$$

The thicknesses with thermal conductivities of various wall layers are denoted by ek and k, respectively [34]. /1hi+1/he= zero.17 m2/W/K is the The quantity of heat that enters through both the exterior wall. a numerical formula The researchers were using a To measure resistance of thermal at hollow material at a diameter 30 mm, with a density of 720 kg/m3, a thermal conduction of zero.51 W/m/K, and a thermal resistance of R= m2/W/K [6]

DISCUSSIONS AND RESULTS

Bulk Density Calculation

The bulk density of samples can be conveniently measured using their weight and dimensions. density findings for types samples are shown in Table 2. For a volume fraction, the benefit in lightness was up to 66 percent (respectively 61 percent). Similar findings have previously been published in studies of cork-based. low density (160 Kg/m3) relative to density of clays used may explain findings. Furthermore, the addition of holes consistence to the clay composite will increase its lightness as shown in Figure 4

Table 2. Results of bulk density measurement

Sample	**Holes volume fraction**	**ρ (Kg/m^3)**
Clay	0	482
Central hole	3.5	421
Lengthily hole	34	295

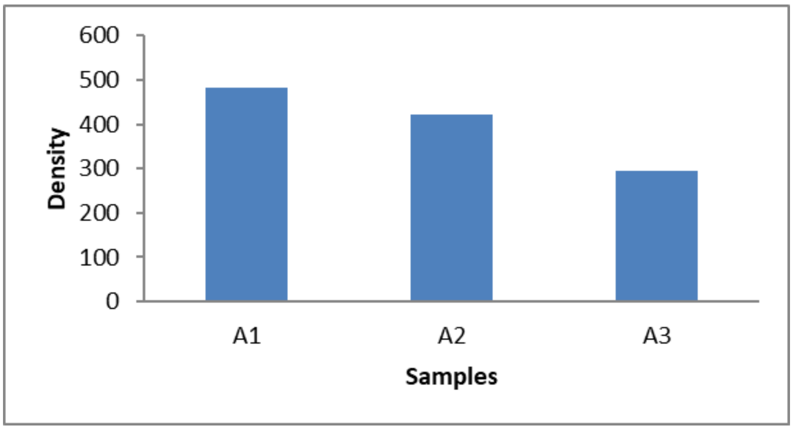

Figure 4. Bulk density with samples

Thermal Conductivity

Table 3 summarizes the thermal conductivity test results for samples. The key values of measurements for every sample are the findings. There are many conclusions that may be drawn. First, holes of clay create a construction area with wonderful thermal Distracting as compared to clay alone. The findings are per previous analysis that shows that combining with plaster [5, 6,35], mortar [8], and linear holes leads to little distracting than central holes with terribly attention-grabbing gains in thermal physical. As a consequence, air may be a stronger material than associate material. As a result, this arrangement of engineered holes helps entice Particles in the air, convection limits, and radiation phenomena, and therefore taking advantage of still air's wonderful thermal potency as shown in Figure 5.

Table 3. Experimental results of thermal conductivity

Samples	Thermal conductivity (W/m/K)
Clay	0.71
Central holes	0.22
Linear holes	0.36

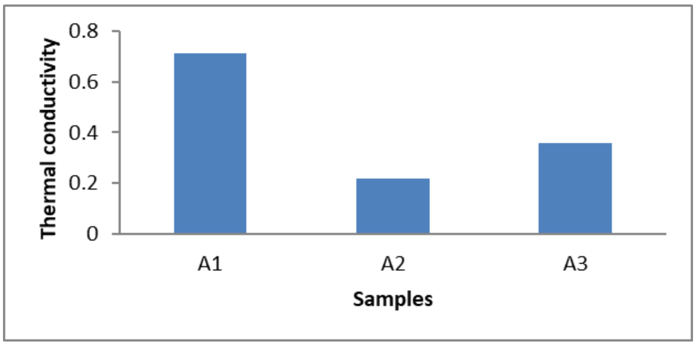

Figure 5. Thermal conductivity with samples test

Efficiency Of Hollow Material's Energy

The heat transmission issue, energy savings walls, the first made from hollow materials and therefore the alternative of standard clay bricks were contrasted. The thermal potency of recent dwellings is calculable exploitation transmission of thermal issue on their parts. set minimum thermal transmission issue for external walls of 0.55 W/m2/K for all temperature zones [36]. altogether of the cases studied, Figure 4 indicates the thermal transmission current problems results as against the thickness of the interface. Figure 6 shows that because the variable layer's thickness is inflated, the thermal transmission issue decreases, as a result, heat loss by external walls is reduced. This reduces the number of energies required to cool down and warmth the houses' interior environments. it is also price noting that a 20mm intermediate layer thickness to be revered.

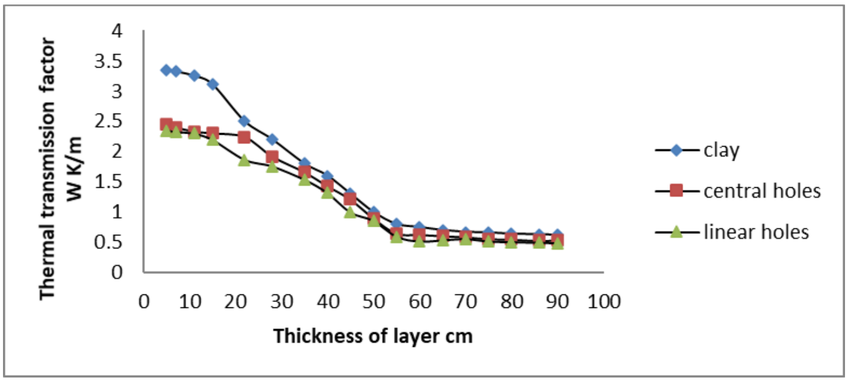

Figure 6. Thermal transmission with thickness of wall

CONCLUSIONS

The result of artificial porousness made inside a clay-cork on its density with thermal properties is investigated during this paper. two completely different clay samples, one from central holes and therefore the different from the linear holes were examined. From the interpretation of the findings, the subsequent conclusions is drawn: to start, chemical and composition of Babelon clays demonstrate suitableness for creating clay bricks. quartz with Illite area unit the foremost common minerals. Low physical property, non-shrinkage, nice forming distinguish them. Second, once granular cork is combined with clay, it creates a light-weight composite with wonderful thermal potency when put next to clay alone. Third, adding air holes to the clay-cork composite will increase its lightness and energy potency. The designed holes permit air particles to be at bay inside encircled cavities. As a result of the low thermal conduction of still air (0.026 W/m/K), convection and radiation phenomena is reduced. Finally, victimisation the new material rather than ancient clay bricks permits for vital energy savings and so lowers prices. dioxide emissions area unit cut in 0.5. Indeed, it reduces thermal transmission and will increase heat flow resistance. External walls provide diffusion. The findings of this study are very promising, indicating that artificial porosity may be useful in a variety of applications. relevant configurations that allow for the use of still air's excellent thermal properties As a result, the best is possible. Controlling energy consumption in the construction industry and improving environmental efficiency are two ways to support the idea. of long-term construction.

REFERENCES

[1] J. Adamczyk, and R. Dylewski, “The impact of thermal insulation investments on sustainability in the construction sector”, Renew. Sustain. Energy Rev., Vol. 80, Pp. 421–429, 2017.

[2] A.A. Taher, A.M. Takhakh, and S.M. Thaha, “Experimental study and prediction the mechanical properties of nano-joining composite polymers”, Journal of Engineering and Applied Sciences, 13 (18), Pp. 7665–7669, 2018.

[3] G. Manioglu, and Z. Yilmaz, “Economic evaluation of the building envelope and operation period of heating system in terms of thermal comfort”, Energy Build., Vol. 38, Pp. 266–272, 2006.

[4] F. Kheiri, “A review on optimization methods applied in energy-efficient building geometry and envelope design”, Renew. Sustain. Energy Rev., Vol. 92, Pp. 897–920, 2018.

[5] A. Cherki, B. Remy, A. Khabbazi, Y. Jannot, and D. Baillis, “Experimental thermal properties characterization of insulating cork–gypsum composite”, Constr. Build. Mater., Vol. 54, Pp. 202–209, 2014.

[6] A.H. Dhiaa, A.A. Taher, A.A. Diwan, S.M. Thahab, and R.J. Azez, “Study the thermal properties of PVP/CuNPs composite prepared by different concentrations”, IOP Conference Series: Materials Science and Engineering, Vol. 870, No. 1, Pp. 012153, 2020.

[7] A.A. Taher, A.M. Takhakh, and S.M.O.P. Thahab, “Experimental study of improvement shear strength and moisture effect PVP adhesive joints by addition PVA”, Conference Series: Materials Science and Engineering, Vol. 454, No. 1, Pp. 012011, 2018.

[8] S. Mounir, K. abdelhamid, and Y. Maaloufa, “Thermal Inertia for Composite Materials White Cement-cork, Cement Mortar-cork, and Plaster-cork”, Energy Procedia, Vol. 74, Pp. 991–999, 2015.

[9] T. Zhang, Y. Tan, H. Yang, and X. Zhang, “The application of air layers in building envelopes: A review”, Appl. Energy., Vol. 165, Pp. 707–734, 2016.

[10] R.A. Agathokleous, and S.A. Kalogirou, “Double skin facades (DSF) and building integrated photovoltaics (BIPV): A review of configurations and heat transfer characteristics”, Renew. Energy., Vol. 89, Pp. 743–756, 2016.

[11] O. Saadatian, K. Sopian, C.H. Lim, N. Asim, and M.Y. Sulaiman, “Trombe walls: A review of opportunities and challenges in research and development”, Renew. Sustain. Energy Rev., Vol. 16, Pp. 6340–6351, 2012.

[12] E. Colombo, M. Zwahlen, M. Frey, and J. Loux, “Design of a glazed double-façade by means of coupled CFD and building performance simulation”, Energy Procedia, Vol. 122, Pp. 355–360, 2017.

[13] C. Zhang, W. Gang, J. Wang, X. Xu, and Q. Du, “Experimental investigation and dynamic modeling of a triple-glazed exhaust air window with built-in venetian blinds in the cooling season”, Appl. Therm. Eng., Vol. 140, Pp. 73–85, 2018.

[14] S.S. Chu, T.H. Fang, and W.J. Chang, “Modelling of coupled heat and moisture transfer in porous construction materials”, Math. Comput. Model., Vol. 50, Pp. 1195–1204, 2009.

[15] C. Zhang, J. Wang, L. Li, and W. Gang, “Dynamic thermal performance and parametric analysis of a heat recovery building envelope based on air-permeable porous materials”, Energy, Pp. 116-361, 2019.

[16] M. Sutcu, J.J. del Coz Díaz, F.P. Álvarez Rabanal, O. Gencel, and S. Akkurt, “Thermal performance optimization of hollow clay bricks made up of paper waste”, Energy Build., Vol. 75, Pp. 96–108, 2014.

[17] H.K. Kim, J.H. Jeon, and H.K. Lee, “Mechanical and Chemical Characteristics of Bottom Ash Aggregates Cold-bonded with Fly Ash”, Constr. Build. Mater., Vol. 29, Pp. 193–200, 2012.

[18] A. Mohammed, A.T. Abdalzahra, and A.A. Taher, Mechanical Properties of Epoxy/ Juteyarns Composite Materials, Vol. 25, No. 4, 2021, Pp. 744 - 753.

[19] A.A. Taher, A. Mohammed, M.H. Al-Hatemmi, and H.J. Jabber, "Study rheometric, physic-mechanical properties of nitrile butadiene rubber blended with hydrogenated nitrile butadiene rubber as a model of sustainable", Journal of Green Engineering, Vol. 11, No. 1, Pp. 29 – 38, 2021.

[20] A.T. Abdalzahra, and A.A. Taher, "A dynamic Analytical Approach to Nonlinear Stall-Spin Aircraft", Journal of Mechanical Engineering Research and Developments, Vol. 44, No. 1, Pp. 422-434, 2021.

[21] A.S. Hammood, M.H.R. Al karaishi, A.A. Taher, and L.J. Habeeb, "Effect of different natural composite material lyres on structural analysis of Aircraft body", Journal of Mechanical Engineering Research and Developments, Vol. 44, No. 5, Pp. 339-344, 2021.

[22] E. Kamseu, B. Nait-Ali, M.C. Bignozzi, C. Leonelli, S. Rossignol, and D.S. Smith, "Bulk composition and microstructure dependence of effective thermal conductivity of porous inorganic polymer cements", J. Eur. Ceram. Soc., Vol. 32, Pp. 1593–1603, 2012.

[23] V. Kozí, Z. Bažantová, and R. Cerný, "Bloodied vs full health PA builds : fo76 – Reddit", Energy Build., 76, Pp. 211–218, 2014.

[24] Y. Jannot, "Théorie et pratique de la métrologie thermique, Lab", D'Energétique Mécanique Théorique Appliquée LEMTA. (2011).

[25] Y. Jannot, B. Remy, A. Degiovanni, High Temp.-High Press. **39**, 1–21(2009).

[26] F.E. Fgaier, Conception, production et qualification des briques en terre cuite et en terre crue, (n.d.) 123.

[27] N. El Yakoubi, "Potentialités d'utilisation des argiles marocaines dans l'industrie céramique: cas des gisements de Jbel Kharrou et de Benhmed (Meseta marocaine occidentale)," Ph.D. thesis, Mohammed VUniversity, 2006.

[28] A.B. Laibi, M. Gomina, B. Sorgho, E. Sagbo, P. Blanchart, M. Boutouil, D.K.C. Sohounhloule, Int. J. Biol. Chem. Sci. **11**, 499-514–514 (2017).

[29] F. Bergaya, G. Lagaly, Handbook of clay science, Newnes, 2013.

[30] M.I. Carretero, M. Dondi, B. Fabbri, M. Raimondo, Appl. Clay Sci. **20**, 301–306 (2002).

[31] S.P. Silva, M.A. Sabino, E.M. Fernandes, V.M. Correlo, L.F. Boesel, R.L. Reis, Int. Mater. Rev. **50**, 345–365(2005).

[32] Al-Akaishi, Ahmed Salih, Muna Hameed Alturaihi, Hazim Jassim Jaber, Ahmed A. Taher, Experimental Study of Thermal conductivity of Ag Nanofluid,Vol. 44, No. 4, pp. 368-372, 2021 .

[33] L. Gil, Cork, in: M.C. Gonçalves, F. Margarido (Eds.), Mater. Constr. Civ. Eng., Springer International Publishing, Cham, 2015: pp. 585–627.

[34] E.C. for Standardization, EN ISO 6946-2007, Building Components and Building Elements, Thermal Resistance and Thermal Transmittance, Calculation Method: December 2007, European Committee for Standardization, 2007.

[35] F. Z. El Wardi, A. Khabbazi, C. Bencheikh, H. Ennaceri, A. Khaldoun, in: 2017 Int. Renew. Sustain. Energy Conf. IRSEC, 2017: pp. 1–6.

[36] ADEREE, 2011, Règlement thermique de construction au Maroc, 46.