Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 161 (2016) 337 – 342

Procedia Engineering

www.elsevier.com/locate/procedia

World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2016, WMCAUS 2016

Changes of Clinker Microstructure After Long-Term Influence of External Environment

Maria Wesołowska[a,*], Anna Kaczmarek[a]

[a]*University of Science and Technology in Bydgoszcz, Department of Building and Building Physics, Kaliskiego 7, 85-796 Bydgoszcz, Poland*

Abstract

Contemporary clinker elements because of numerous colours and shapes give uncountable opportunities for architectural compositions. Apart from undeniable aesthetic values they are characterized with high resistance to environment influence. It is associated both with clinker microstructure as with adopted mortar types. By definition a facial wall has an attractive look which should be maintained during the whole period of the construction usage. However, it often occurs that the intended effect has not been reached. On majority of buildings during the first years of using there are efflorescence's appearing, covering mainly clinker surface. They are primary efflorescence's which should disappear during the first year of exploitation. The multi-year work led by the authors on real objects indicate that this period is definitely longer and efflorescence change according to seasons. The cyclic influence of salts changes the clinker microstructure. This work concerns the clinker microstructure and its changes resulting from ten years of exposition on external climate conditions. The researches were led on field station localized on area of the University of Science and Technology Bydgoszcz (Poland).

Peer-review under responsibility of the organizing committee of WMCAUS 2016

Keywords: clinker brick, mercury porosimetry, facing walls, impact of climate;

For analysis three clinker brick walls were selected, each built with different mortar: Portland cement based CEM I, Portland cement based CEM I with plasticizer and cement-lime mortar. From bricks designed for building there were taken 6 random samples which was initial material for microstructure evaluation. The researches were led on facial layer of bricks 5mm thick. Basing on long-term observation a wall area was indicated with the highest efflorescence intensity. For each wall from the selected area 6 samples of clinker were taken of 5 mm thickness. For microstructure

* Corresponding author. Tel.: +48 523408679.
*E-mail address:*marysia@utp.edu.pl

Peer-review under responsibility of the organizing committee of WMCAUS 2016
doi:10.1016/j.proeng.2016.08.569

evaluation the mercury porosimetry method was used. The results obtained were used to comparative analysis of changes in meso and macro pores in clinker after ten years of functioning in external environment.

1. Introduction

One of problems of contemporary facial walls is lowering their esthetics caused by salt crystallization. Independent of used of wall unit - mortar system, on most of new objects during the first years of functioning there are efflorescence's appearing with various intensity and chemical compound. There are three main factors causing efflorescence's, [1]:

– presence of soluble salts in water,
– water penetration into a wall, where salts are to be dissolved,
– presence of a factor which causes salt solution movement.

Researches led on real building objects where residual efflorescence occurrence was found indicate that essential role is played by environment factors [2]. They include: atmospheric rainfall, splash water, penetrating water (for instance water supply defects), ground humidity, persisting snow cover. They cause direct deposition of chemical pollutant into the wall. The second group are internal factors which include built-in material properties and their interactions. During last years it has been noticed much interest in numerical research of mineral salt transport in porous material [3, 4, 5]. The mathematical models created and results gain in experimental research in significant way contributed in development of computer programs modeling influence of salt crystallization process on building material strength and in consequence on facial wall durability [6, 7, 9,10].

Simulation research indicates that in case of brick wall, surface tension can amount to values close to brick strength tension equal about $1N/mm^2$ [8]. It can lead to scars and wall surface defects. Since 2006 in premises of University of Science and Technology in Bydgoszcz (Poland) it has been functioning a field test station for facial walls esthetics and durability evaluation. The walls were shaped in a way that they include most typical external environment impacts: atmospheric rainfall and soil contact. For observation of rain influence the wall top and cornices were adequately modeled which enabled intensive water bruising and flowing.

The chemical analyses of brick samples taken from the test station showed that the highest salt concentration is located in surface layer 5 mm thick. Basing on multi-year research it was stated that the crystallization process is cyclic with special intensity in spring (April for the discussed localization). In subsequent years of observation, the increase in efflorescence intensity was noticed which can suggest ongoing changes in clinker microstructure.

2. Research methods

2.1. Field station

The field test station for research was localized in area of the University of Science and Technology in Bydgoszcz (Poland). The research station includes eight test walls one brick thick and measuring 1,61 x 1,42 m. The walls were placed with sides directed at wind stated according to reports by Voivodships Inspectorate of Environment Protection in Bydgoszcz (Poland). They were built with full clinker brick in sets of eight different mortars of which six had known material composition and two other were ready-made with indication for use in facial walls in order to avoid efflorescence's (Picture 1). For purpose of this article 3 walls were chosen with mortars which composition were given in Table 1.

In a such designed wall anti-humidity insulation was made on two levels:

- on foundation wall (10cm under ground level),
- 50cm above the ground level.

The insulation was intended to protect against water migration from concrete foundation and select the area endangered with splash water.