



DOI: <http://dx.medra.org/10.14597/infraeco.2015.2.2.031>

ANALYSIS OF EXISTING CONCRETE TILES ROOFING IN AGRICULTURAL HOLDINGS ON A SELECTED EXAMPLE

Grzegorz Nawalany, Piotr Herbut, Paweł Sokołowski, Aleksandra Gryc
University of Agriculture in Krakow

Summary

The paper presents analysis of existing concrete tiles roofing on outbuildings in selected localities of the Pińczów district. On the basis of the observations on the spot it was established that concrete tiles constitute 18% of all roof coverings in the investigated area. It is the most frequently used on livestock housing. It was noticed that of all concrete tiles, 81% are the products manufactured using traditional methods, directly on the construction site. Water absorption by weight was determined for selected concrete tiles in order to assess the technical state of existing concrete tiles roofing. The tests of water absorption by weight revealed about 1.6% lower water absorption for tiles mass produced by industry than for traditionally manufactured ones. The tiles utilised on buildings for more than 40 years were characterised by even 0.7% increase in water absorption by weight in comparison with non-utilised tiles.

Key words: roofing, concrete tiles, water absorption by weight

INTRODUCTION

One of the most important functions of the roof is protection of walls and ceilings against unfavourable effect of external factors. Analysis of the materials used for manufacturing roof coverings revealed their considerable diversification. The most popular roofing materials comprise among others: steel tiles, trapezoidal metals sheets, concrete and ceramic tiles and bituminous shingle (Pluta 2005). Quality assessment of ceramic and concrete tiles roofing should

comprise quality assessment of the roofing and auxiliary materials, evaluation of the correctness of roof underlays construction and assessment of the correctness of covering and other roof work completion (Francke 2013).

Mass production of concrete tiles, used on both residential buildings and outbuildings, was most popular in the fifties of the 20th century. It was due mainly to a huge demand for building materials after the end of World War II. It resulted in developing one technology which made possible mechanical production of these tiles. It was the idea of German entrepreneur Rudolf Brass and his technology has been used to this day. However, it should be noticed that both concrete and ceramic materials were hardly available at that time because they were treated as “basic commodities” (Rak et al. 2007). Therefore many building materials, including concrete tiles, were manufactured by builders themselves using traditional methods. A simple manufacturing process led to its wider use on residential buildings, outbuildings and livestock housing. Previously conducted research demonstrated that concrete tiles roofing, particularly in farm building constitutes a considerable proportion of the roofing materials (Herbut and Nawalany 2014). However, physical properties of materials produced on the construction site may differ from mass produced products. One of the parameters which directly affects tiles durability is their water absorption by weight. High value of this parameter combined with low ambient temperatures shorten the lifetime of the tiles as a roofing material (Stolecki and Murzyn 2009). The problem is most important, both for concrete and ceramic materials. Consequently, various investigations were conducted to find a possibility to protect tiles against moisture by e.g. water proofing. However, according to Barnat-Hunek and Iwanek (2011), initial tiles tests should be conducted prior to using water proofing preparations to assess the efficiency of the process.

The presented paper strives to assess the technical state of the existing concrete tiles roofing in the area of Pinczów district. The objective was realised by means of survey studies carried out on selected farms and through a comparative analysis of water absorption by weight of tiles manufactured 40-50 years ago using traditional method and the tiles utilised on the existing farm building roofs with currently commercially produced concrete tiles.

AIM AND SCOPE OF RESEARCH

The investigations aimed at an analysis of the existing roofing on farm buildings and livestock housing in the area of Pinczów district with particular regard to concrete tiles. The scope of research comprised inventory of concrete tiles roofing and comparative analysis of concrete tiles water absorption by weigh. Water absorption by weight is one of more important physical properties of tiles affecting the quality of roofing materials.

MATERIAL AND METHODS

The investigations covered 193 agricultural holdings located in the Pińczów district: in Bogucice, Marzęcin, Pasturka, Kowala and Grochowiska villages where the analysis of roofing was conducted for 234 buildings. The first stage of research involved observation on the spot combined with the inventory of existing roofing in selected agricultural holdings. At the next stage, an analysis of the proportion of existing concrete tiles roofing was conducted and their technical state was assessed. Water absorption by weight was determined for selected concrete tiles from animal housing and outbuildings and the obtained results were compared with water absorption by weight of the currently manufactured products.

Water absorption by weight tests were conducted on the basis of PN-85/B-04500 standard. The analysis covered the mass produced tiles and the tiles manufactured in 1960-1970 using a traditional method, directly on the construction site (tiles non-utilised on a building roof and originating from utilised roofing). Tiles commercially mass produced by four leading producers on the market were selected for analysis.

RESULTS AND ANALYSIS

Characteristics of existing concrete tiles roofing

On the basis of the analysis of data obtained from surveys and site inventory it was found that asbestos shingles were the most frequent roofing material, constituting 36% of all roof coverings on the analysed objects. The proportion of concrete tiles was 8% (42 buildings). Detailed list of materials used for roofing and their proportions in the analysed farms was presented in Table 1.

Table 1. Proportion of roofing on outbuildings in Pińczów district

Roofing materials	Number of buildings (pcs.)	Proportion (%)
Asbestos shingles	84	36
Sheeting	51	22
Concrete tiles	42	18
Ceramic tiles	38	16
Roofing felt (traditional flat roof))	19	8
Total	234	100

Greatly diversified agricultural production was observed in the localities under investigations. A majority of agricultural holdings were small farms with area of several hectares conducting small scale livestock breeding. Prevailing buildings are used for breeding several kinds of animals or used as outbuildings and storage facilities. The list of individual kinds of buildings covered by concrete tiles was presented in Table 2.

Table 2. Buildings with concrete tiles roofing in Pińczów district

Kind of building	Number of buildings (pcs.)	Percentage
Cowsheds	6	14
Pigsties	3	7
Stables	2	5
Barns	8	19
Other	23	55
Total	42	100

Table 3 presents the development of concrete tiles roofing on outbuildings in Pinczów district. Concrete tiles were the most frequently used roofing in 1960-1970 (almost 40% of buildings originate from this period), in the later period concrete tiles were used less frequently, among others due to increasingly better availability of fibre cement roof sheets, which enabled the roof making during a definitely shorter period and at that time was regarded as a modern and more durable material than concrete tiles.

Table 3. Development of concrete tiles roofing in the Pinczów district

Period of tiles manufacturing	Number of buildings (pcs.)	Percentage
before 1960	8	19
1960-1970	17	40
1970-1980	12	29
1980-1990	3	7
after 1990	2	5
Total	42	100

While analysing the occurrence of concrete tile in view of its kinds, it may be noticed that traditional gutter tile was the most frequently used in Pinczów district. In all cases it was produced on the building site by builders using a traditional method. This kind constitutes 81% of all tiles used on the inventoried roof

slopes. Only on 8 buildings the roofing was made of other kind of concrete tiles (double Roman tile – 8 buildings, pantile – 2 buildings). However, totally they made up only 19% (Tab.4).

Table 4. Kinds of concrete tiles used on outbuildings in Pinczów district

Kind of concret tile	Number of buildings (pcs.)	Percentage
Traditional gutter	34	81
Double Roman	6	14
Pantile	2	5
Total	42	100

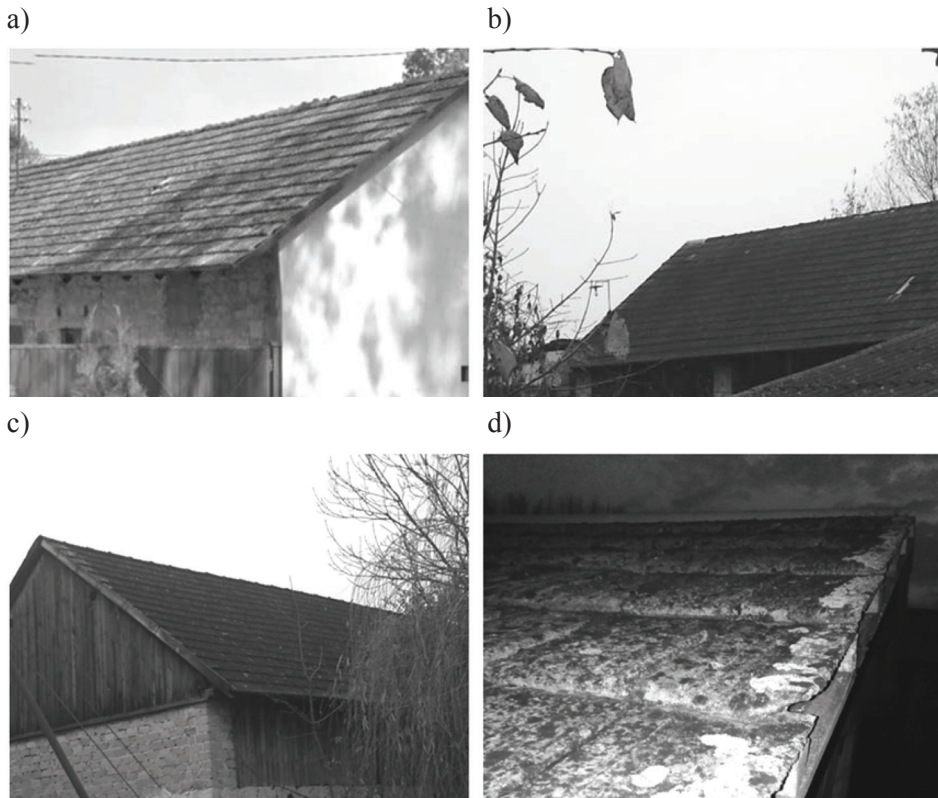


Figure 1. Examples of outbuildings in Bogucice with concrete tiles roofing:
a) pigsty, b) cowshed, c) barn, d) henhouse

Photographic documentation was made during the investigations and observations on the spot, illustrating current state of roofing with particular regard to concrete tiles. Figure 1 shows photographs of the buildings covered by gutter tiles manufactured by traditional method. Observations on the spot revealed a diversified state of concrete tiles. A relationship between the type of building with concrete tile roofing and the degree of its wear was observed. Concrete tiles on animal housing revealed a higher degree of damage than on the outbuildings. The reason may be higher concentration of harmful gases (e.g. ammonia or hydrogen sulphide) in the environment of livestock housing.

Analysis of the technical state of concrete tiles roofing

In order to determine the technical state of concrete tiles, comparative studies of the tiles water absorption by weight were conducted for the tiles manufactured using traditional method at the turn of the 1960s and 1970s with commercially produced ones. Figure 2 shows compilation of mean water absorption values for all tested tiles.

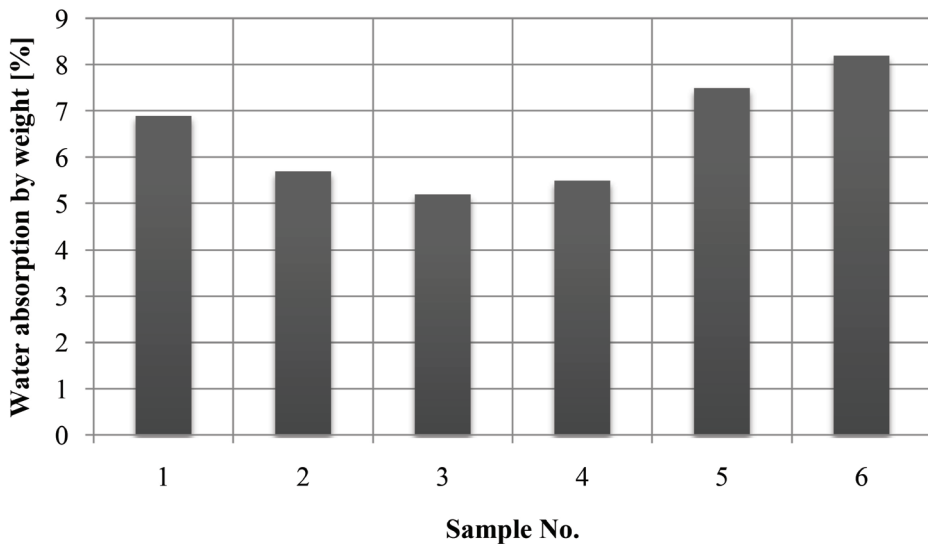


Figure 2. Mean water absorption by weight of the tested concrete tiles: samples 1-4 – tiles manufactured by industrial production method; sample 5 – non-utilised tile, manufactured by traditional method in 1960-1970; sample 6 – tile used for over 40 years, manufactured by traditional method

Mass produced concrete tiles are characterised by different water absorption by weight, depending on the manufacturer. Water absorption by weight of

these tiles fluctuated from 5.2% to 6.9% with average water absorption 5.8% (Kadłubowski 2006). In case of tiles manufactured by traditional method, mean water absorption by weight was higher, reaching 7.5%. Tiles produced by traditional method and utilised for longer than 40 years revealed increased water absorption by weight by about 0.7% in relation to non-utilised tiles. Higher value of this parameter may affect faster wear of this material. The investigations demonstrated that concrete tiles roofing manufactured by traditional method have numerous damages, such as chips or cracks. Because of washing out of the cement paste from the tile surface on a majority of northern roof slopes, moss overgrowing the tiles was noticed.

CONCLUSION

Proportion of concrete tile as roofing on the animal housing in the Pińczów district was 18%. Prevailing were concrete tiles manufactured by traditional method in 1960-1970. Analysis of water absorption by weight of concrete tiles revealed that the tiles manufactured by traditional method on construction site were characterised by 7.5% water absorption by weight, which was about 1.6% higher than water absorption by weight of commercially produced tiles. Utilisation of tiles leads to the increase in their water absorption by weight. Concrete tiles from animal housing roofing revealed a higher degree of wear than these used on other farm buildings. The investigations demonstrated that after 40 years of use concrete tiles had 0.7% higher water absorption than those, which were not utilised on the roof. Increase in water absorption by weight of the utilised tiles may affect damages in consequence leading to leaks in the roofing. It is estimated that in the nearest future the existing roofing on farm buildings made of concrete tiles and asbestos roof shingles, in vast majority will be replaced by roofing of e.g. steel tiles or trapezoid sheets.

REFERENCES

- Barnat-Hunek D., Iwanek A. (2011). *Analiza skuteczności hydrofobizacji powierzchniowej dachówki i cegły ceramicznej*. Materiały ceramiczne, Tom: 63, Nr: 3, s. 484-489.
- Francke B. (2013). *Metody oceny jakości wykonania pokryć dachowych z dachówek ceramicznych i cementowych*. Materiały Budowlane, Nr: 6, s. 14-16.
- Herbut P., Nawalany G. (2013). *Analiza istniejących azbestowych pokryć dachowych budynków w gospodarstwach rolnych na wybranym przykładzie*. Infrastruktura i Ekologia Terenów Wiejskich. PAN. Komisja Technicznej Infrastruktury Wsi. Kraków. I/1/2014 s.103-110.

- Kadłubowski Ł. (2006). *Badanie nasiąkliwości wagowej dachówek cementowych*. Niepublikowana praca magisterska, Wydział Inżynierii Środowiska AR w Krakowie.
- Pluta A. (2005). *Materiały na pokrycia dachowe*. Materiały Budowlane, Nr: 6, s. 22-23. PN-85/B-04500 *Zaprawy budowlane. Badania cech fizycznych i wytrzymałościowych*.
- Rak L., Kielski A., Mandecka-Kamień L. (2007). *Sytuacja przemysłu wytwarzającego cegły budowlane i dachówki w Polsce*. Materiały Ceramiczne. Tom: 59, Nr: 4, s. 156-161
- Stolecki J., Murzyn P. (2009). *Właściwości ceramicznych tworzyw dachówkowych*. Materiały Ceramiczne, Tom: 61, Nr: 1, s. 21-26.

Dr hab. inż. Grzegorz Nawalany
g.nawalany@ur.krakow.pl
Dr hab. inż. arch. Piotr Herbut
p.herbut@ur.krakow.pl
Mgr inż. Paweł Sokołowski
p.sokolowski@aur.krakow.pl
Dr inż. Aleksandra Gryc
a.gryc@ur.krakow.pl
University of Agriculture in Krakow
Department of Rural Building,
al. Mickiewicza 24-28, 30-059 Kraków
kbw@ur.krakow.pl
+48 (12) 662 40 09

Received: 03.01.2015

Accepted: 14.05.2015