CUSTOMERS PERCEPTION OF THE CHARACTERISTICS OF MORTARS ON THE MARKET

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Abstract: *Mortars are an essential part of a built structure and play a protective role against buildings degradation, being well homogenized mixtures of binder, water and fine aggregate. Binders are mineral powders with different chemical compositions, which together with water form plastic pastes that harden over time due to physical or chemical processes. Lime is an important component of the mortar used since ancient times, presenting many advantages: very good workability being a natural plasticizer, high water retention capacity, gives the mortar its resistance to stretching and elasticity, ensures the breathing of the walls and is economical. Due to their nature and function, mortars are sacrificial materials with a much shorter service life than the stone elements with which they mixed, and for these reasons, historical mortars degrade and often need to be replaced. Rehabilitation and preservation mortars for old buildings have different characteristics from those developed for contemporary works. The choice of the type of mortar used for historical buildings restauration depends on the historical mortar composition and the factors that led to its degradation. Is considered that a compatible restoration mortar is that type of mortar that acts similarly to old mortars, with different types of action (such as static or hydrothermal) and that does not create or aggravate new types of damage. Knowing the characteristics of historical and contemporary mortars is essential in choosing the type of restoration mortar. This paper is a study on the characteristics and components of contemporary mortars compatible with historical mortars used in the masonry of heritage buildings.In this respect, the characteristics and composition of the mortars existing on the market, as well as the consumer's perception of their properties, were investigate.*

Keywords*: mortar characteristics, compatible restoration mortar, preservation, masonry*

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Introduction

Since ancient times people have used elements found in nature as building materials.

Mortar is one of the important elements in masonry because it ensures adhesion between masonry elements, helps to distribute stress between masonry layers, and contributes to thermal and sound insulation (Thambool et al., 2019).

Mortars are well-homogenised mixtures of binder, water and fine aggregate, which are applied in a thin layer to any substrate to which they adhere and with which they work in service, and after hardening give an artificial stone with the appearance of sandstone (Piper, 2013).

Depending on their intended use, mortars may be masonry mortars or plastering mortars.

The basic binders used for making mortars are lime, cement, plaster, or clay.

Since ancient times the binder used for making mortar has been lime because of its availability.

Lime is a natural rock formed by the sedimentation of shells, corals, algae, faeces, and other organic debris, as well as by chemical sedimentation processes such as the precipitation of calcium carbonate from lake or ocean water.

The earliest documented use of lime as a building material was around 4000 BC, when it was used by the Egyptians to plaster pyramids.

Lime possesses several properties that recommend it as the main binder in mortar composition. Lime is a natural plasticizer which gives mortar high workability, has a high-water retention capacity, and improves the bonding of elements in masonry giving resistance to stretching.

The presence of lime in mortar and plaster ensures that walls breathe and prevents efflorescence (Carmeuse, 2008).

Several historic buildings around the world have been built using lime-based mortar mixed with various additions: crushed brick, pozzolan, (Frankeova, Koudelkova, 2020), volcanic tuff or ceramic waste (Degryseal et al, 2002).

Lime-based mortars have been identified in heritage buildings in Romania, thus at Voroneț Monastery a mixture of lime mortar mixed with sand and crushed brick was used and at Humor Monastery the mortar used for masonry was a mixture of lime and sand (Pintea, 2019).

Due to its properties, gypsum is a material that has always been used in construction, the oldest applications of gypsum have been dated by archaeologists to around 7000 BC.

It has very good stability to changes in humidity, is easily malleable and has a short curing time. However, gypsum also has some limitations that limit its applications in construction, such as its lack of strength and high rate of decay.

To improve the properties of gypsum used as a binder in masonry mortars or plasters, several aggregate compounds or additives can be added to the mix.

Worldwide concern for environmental protection has prompted the search for new solutions to reduce the amount of waste from construction activities. Thus, a wide range of construction waste materials have been identified and studied as components of gypsum-based mortars: Expanded polystyrene (EPS) waste, Waste rubber, Plastic cable waste, Wood waste, Polymeric residues, Ceramic wastes, Mineral wool residues and Glass waste powder.

In this respect, studies have shown that the use of construction and demolition waste to replace some gypsum or other aggregates, such as sand, in gypsum mortars reduces gypsum density, decreases water absorption, and improves the mechanical properties of gypsum Rio-Merino et al, 2022).

Most modern mortars use Portland cement as a binder mixed with a fine aggregate such as sand. Portland cement is generally a fine powder resulting from grinding a mixture of cement clinker and gypsum.

The mineralogical composition of Portland cement clinker can vary, depending on the chemical composition of the raw materials used and the manufacturing technologies. Four mineralogical compounds are predominant in cement clinker: Tricalcium silicate (allite) -

3CaOSiO2 - C3S; Bicalcium silicate (belite) - 2CaOSiO2 - C2S; Tetracalcium ferroaluminate (celite I or brownmillerite) - 4CaOAl2O3F2O3 - C4AF; Tricalcium aluminate (celite II) - 3CaOAl2O3 - C3A.

The main properties of cement related to the influence of mineralogical components are: hydration rate, hydration heat, mechanical strength, resistance to chemical aggressiveness, amount of chemically bound water, etc (Nguyen et al, 2014).

The addition of various polymer compounds (acrylate polymers (AC), polyvinyl alcohol (PVA), styrene-butadiene rubber (SBR), and ethylene-vinyl acetate (EVA)) to the composition of cement-based mortars can lead to increased strength and durability of the material, as well as better adhesion of the material to the substrate (Min Ook Kim, 2020).

Good results have also been obtained by using construction and demolition waste (ceramic elements, glazing, carpentry, thermal insulation) (Imane et al, 2020), polyurethane-based waste (Junco et al, 2012) or plastic waste in combination with portland cement as an environmentally friendly alternative to mortar (Makri et al, 2019).

Regardless of the type of mortar, they must meet a few quality characteristics laid down by the legal standards in force: compressive strength, adhesion and workability.

For ordinary mortars the following characteristics are determined according to STAS 2634-1980 and NE 001-1996: consistency, apparent density, segregation tendency and water retention capacity.

On hardened mortars, according to STAS 2634-1980, the following are determined: apparent density, flexural strength, compressive strength, freeze-thaw strength, adhesion to the substrate and axial shrinkage.

Mortars play an important role in buildings, usually as plasters or jointing mortars, but also as connecting elements between materials, such as wall substrates and tiles. In this area, bond strength is a predominant characteristic for the durability and adequate performance of the connection provided by mortars. This connection meets the requirements if it can provide adequate bond strength, which is distinct for different wall claddings.

The connection between mortar and masonry elements is achieved by two mechanisms: a chemical one (through covalent or Wan der Waals bonds) and a mechanical one created by the mechanical connection of hydration and carbonation products (in cement and/or hydrated lime mortars) transferred to the surface of the masonry porosity (Botas et al, 2017).

A special category is mortars used in the restoration of heritage buildings.

Due to their nature and function, mortars are much shorter-lived materials than the stone elements with which they are mixed, and for these reasons, historic mortars degrade and often need to be replaced.

Rehabilitation and conservation mortars for old buildings have different characteristics from those developed for contemporary work.

The choice of the type of mortar to be used for the restoration of historic buildings is made according to the composition of the historic mortar and the factors that led to its deterioration. A compatible restoration mortar is considered to be that type of mortar which acts similarly to old mortars with different types of action (e.g. static, hydrothermal) and which does not create or aggravate new types of damage (Degryseal, 2002).

Hydrated lime-based mortars have different physical and mechanical characteristics than cement-based mortars or other hydraulic binders, and have several advantages in the conservation, repair and rehabilitation of old buildings: compatibility, durability and reversibility.

The high compatibility of lime-based mortars results in the same characteristics and performance as mortars for old buildings, which ensures their protection and contributes to the durability of the building.

The similar durability of new mortars to old mortars prevents short-term interventions and the reversibility of these mortars allows for repair, decontamination, or cleaning of adjacent

materials (Botas et al, 2017).

The technical characteristics which determined the compatibility between new and old mortar are: surface characteristics (colour, texture, surface finish), mortar composition (type of binder, aggregate and particle size), strength (compressive, tensile and bonding), elasticity and porosity properties (total porosity, application specific weight, pore size distribution, capillary water absorption and vapour transport) (Balden et al, 2005).

The building materials market offers users a wide range of mortars, both powder and fluid, from well-known brands: Holcim, Ceresit, Adeplast, Baumit, Sika, etc.

The type of mortar to be used must consider the intended use and the properties that the mortar must fulfil.

Based on the need to know the characteristics of the mortars required according to their intended use (masonry, plastering or restoration), the present study aims to carry out a market survey of mortar consumers/users to identify the degree of knowledge of the properties and characteristics of the mortars used.

Research methodology

The aim of the article is to determine consumers/users perception toward different types of mortars.

The objectives of the article are:

- to determine the main works where mortars are used
- to determine the main factors that influence the buying decision
- to identify the most important mortar characteristics that determine the buying decision
- to identify the main source of information when deciding to buy mortar

To assess the perception of consumers/users of mortars (natural and legal persons) on the characteristics of mortars on the market, a survey was carried out using a questionnaire.

The questionnaire contains 20 questions, which were used to identify the category of consumer (buyer, seller, user, background, legal status, income), the reasons for the purchase decision (price, characteristics, mode of use, purpose of use, brand, frequency of purchase) and the consumer's expectations regarding product characteristics and price.

The questionnaire also collected socio-demographic data for individuals: level of education (vocational school, high school, university studies), environment of origin (urban or rural), monthly income; and for firms, data were collected on turnover, field of activity (CAEN code), form of organization and number of employees.

Results and discussions

The questionnaire was administered to a sample of 20 consumers/users of mortars of which 12 individuals and 8 legal entities (7 with the form of a limited company and one authorised individual) (fig.no.1).

Regarding the types of works where mortars are used, masonry works were mentioned in 75%, plastering works 70%, interior repairs 65% and exterior repairs 45%.

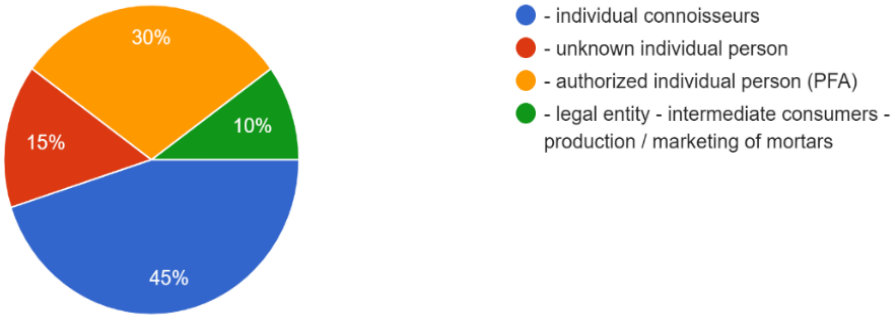

Fig. no. 1 Categories of participants who responded to the questionnaire

Source: is the authors' research on the analysed questionnaires

The individuals interviewed are specialists or non- specialists in construction, 9 of them live in urban areas and 3 of them in rural areas. In terms of the education level of the respondents, 1 person is a graduate, 4 of them are high school graduates and 7 are vocational school graduates. The incomes of the individuals are varied: 2 persons have incomes below 2000 RON, 5 persons have incomes between 2001 and 3000 RON, 1 person between 3001 and 4000 RON, 1 person between 4001 and 5000 RON and 3 persons earn more than 5000 RON.

The legal entities participating in the study carry out activities in the construction sector corresponding to CAEN codes 4120, 4210 and 4291 (construction works of residential and non-residential buildings, road and railway construction works and hydro-technical constructions), being companies with a turnover between 5326 and 2950000 RON, number of employees between 20-80.

Among the correspondents participating in the survey, 1 declared himself a buyer, user and seller of mortar, one is a user and seller of mortar, 13 are buyers and users and one person is only a user of mortar (Fig. no. 2).

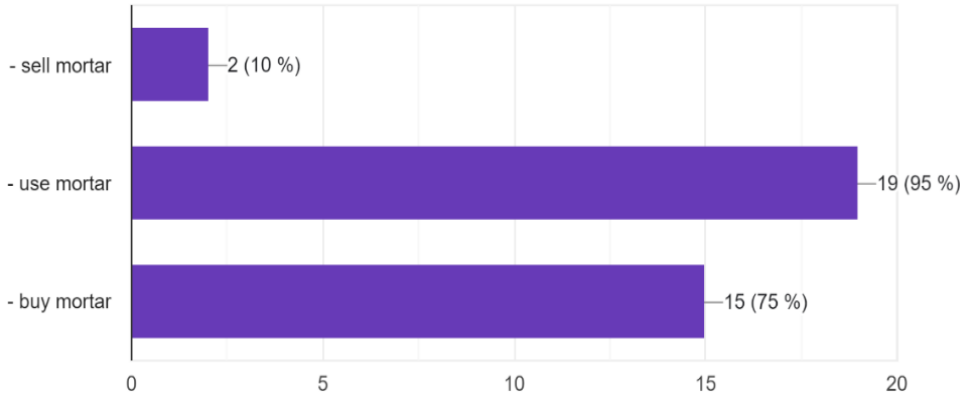

Fig. no. 2 Categories of participants by activity
Source: is the authors' research on the analysed questionnaires

When choosing mortar, the decision is mainly made according to the purpose of the work, the characteristics, but also the price and the way of use.

The purchase decision is 75% influenced by the characteristics of the mortar and the purpose of use. The price is 60% important and the way the mortar is used influences the purchase decision by 30% (Fig. no. 3).

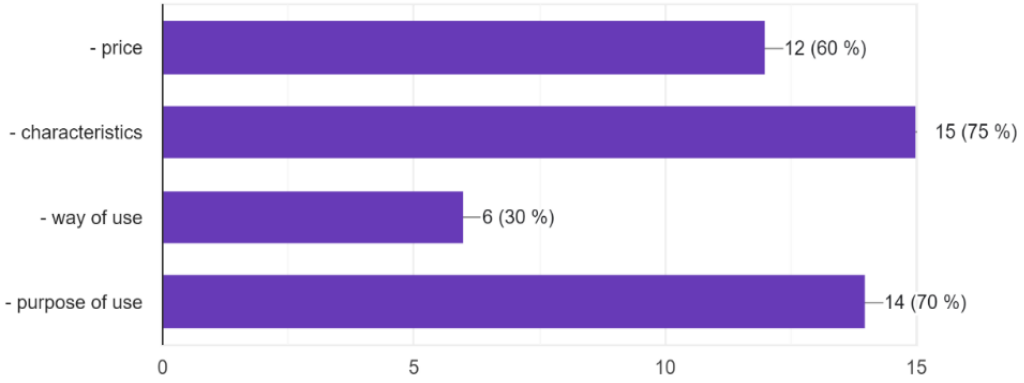

Fig. no. 3 Factors that influence the mortar purchasing decision
Source: is the authors' research on the analysed questionnaires

The predominant characteristics taken into consideration when purchasing mortar are workability, compressive strength and setting time.

Of these, workability is mentioned by 80%, setting time counts for 75%, adhesion and stability are mentioned by 40% of correspondents, compressive strength is followed by a small number of correspondents (35%) and water retention percentage by only 10% of them (fig.4).

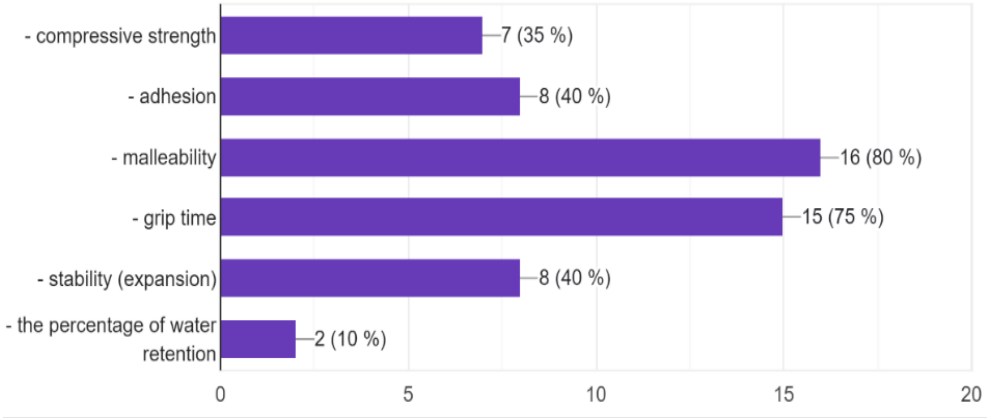

Fig. no. 4 Characteristics that influence the mortar purchasing decision
Source: is the authors' research on the analysed questionnaires

Regarding the types of works where mortars are used, masonry works were mentioned in 75%, plastering works 70%, interior repairs 65% and exterior repairs 45%.

There are many sources of information when buying a mortar: friends, acquaintances, companies, suppliers or specialist forums. The answers collected from the questionnaire show that the main sources of information are the profile companies (75%) and suppliers (60%), but also specialist forums (45%). The other sources of information are mentioned in lower proportions (Fig. no.5).

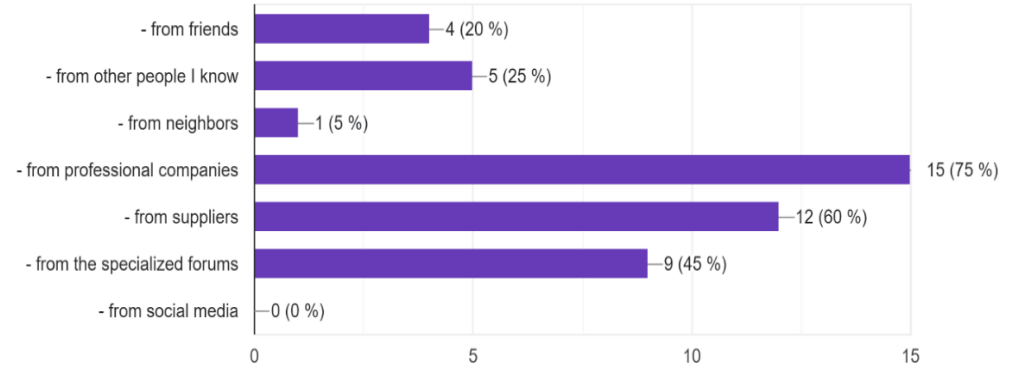

Fig. no. 5 Sources of information when buying mortars
Source: is the authors' research on the analysed questionnaires

On the Romanian market there is a multitude of companies selling mortars.

Of the existing mortar brands on the market, Adeplast is preferred by most of the correspondents (40%), 25% were satisfied with Baumit products, 20% prefer the Ceresit brand and 15% use products manufactured by Holcim (fig.6).

45% of participants buy mortar monthly, 45% buy a few times a year, 5% buy weekly and 5% buy daily.

The quantities that correspondents purchase on average per purchase vary according to their needs and the specifics of their business from 5kg to 5000kg (200 bags * 25kg).

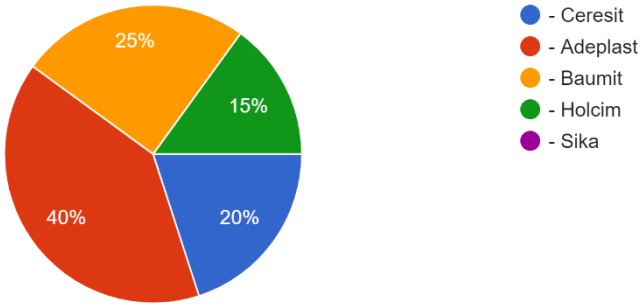

Fig. no. 6 Preferences of the survey participants regarding the mortar brands on market
Source: is the authors' research on the analysed questionnaires

Conclusions

Mortars are essential elements in the structure of buildings, being well homogenised mixtures of binder, water and fine aggregate.

Due to their nature and function, mortars are much shorter-lived materials than the stone elements with which they are mixed, and for these reasons, historic mortars degrade and often need to be replaced.

There are several categories of mortar users: individuals, construction companies, engineers, skilled and unskilled personnel. They use mortars either in construction work carried out by specialised firms or in work carried out in their own homes.

Regardless of the purpose for which mortars are used, it is important to know their properties according to the purpose of the work.

To assess the level of consumer information on the quality characteristics of the mortars available on the market, an evaluation questionnaire was developed and applied, comprising 20 questions divided into 3 sections: section 1 - Mortars (characteristics), section 2 - Socio-demographic data and section 3 - Company data.

The questionnaire was addressed to both knowledgeable and unknowledgeable individuals (amateurs who use mortar occasionally) and legal entities (PFA and construction companies).

There were 10 responses, 4 from legal entities and 6 from individuals.

From the evaluation of the responses the predominant characteristics considered when purchasing mortar are workability, compressive strength and setting time and the most important characteristics expected from a mortar are adhesion and durability to freeze/thaw attack.

Participants in the study use mortar for all types of work: masonry, plastering, interior and exterior repairs.

Of the mortar brands on the market, Adeplast mortar is preferred by 40% of the survey participants.

The variety of responses provided by the participants in the survey indicates that consumers are aware of the properties of masonry mortars, purchasing is done according to the characteristics and purpose of use of the mortar, with documentation being done mainly with the companies and suppliers.

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