DEVELOPMENT OF ALTERNATIVE INORGANIC ADHESIVES

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Adhesives are substances that can hold several materials together in a functional manner by surface attachment that resists separation. Because of the adhesive substance function that those substances are able to hold together several materials, adhesives play integral role in our every day life. Nowadays several scientific societies are interested in adhesive substances because of their relative importance. Their main goal is to improve those adhesive substances and make them more useable and appropriate for 21st century's requirements. Therefore, nowadays-adhesive substances are relevant and topical [1,2].

The research aims is to evaluate scientific achievements related to adhesive materials and underline what sort of challenges scientists have in this field. In addition, we are going to evaluate how achievements and challenges correlates. We will provide you with our alternative, inorganic adhesive substances and results of their application in our work.

In this paper, several research methodologies was discussed due to research topic is multidisciplinary. In particular, most intensively used methodologies are analytical research methodology, comparative research methodology and quantitative and qualitative research methodologies. As already was mentioned, adhesives are integral substances that we need almost in every field in our everyday life but it is important to mention that once there was a time when adhesives did not even exist. If it is so important today, how people could leave without it? This question can lead us to the origin of adhesive materials. It is important to mention that the hides, horns, bones, hooves, and some tissues from animals contained collagen, a tacky substance that was perfect for gluing some things. They also used brains and blood. Fish were also used to make glue. The skin and bones of fish produce a clear adhesive that wouldn't show up when it dried. Those facts clearly indicate that origin of adhesive substances is organic but after some modifications and improvements, it become synthetic and modernized. It should be noted that since adhesives early discovery intensive and important researches have been made in order to obtain high quality, biocompatible adhesives. Organic adhesives that was used many years ago such as bitumen, tree pitches and waxes have been replaced by highly developed natural and synthetic adhesives. Nowadays

important challenge is to obtain high quality, low price and most importantly ecofriendly adhesives to protect our planet from pollution. It should be noted that since 1950 adhesive substances development process has become rapid and intensive. For instance, in 1950 Epoxy alloys based adhesive substances were available. In 1980, Thermoset resin based adhesive substances were available and in 1990, Polyurethane modified epoxy adhesive substances were available. According to above-mentioned information, it is clear that since 1950 adhesive substance development process has become so rapid and intensive.

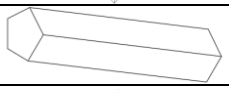
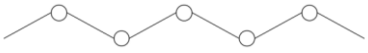
There exist two sorts of adhesive substances organic and inorganic. Organic adhesives also known as Natural adhesives are made from organic sources such as vegetable starch (dextrin), natural resins, or animals (e.g. the milk protein casein and hide-based animal glues). These are often referred to as bio adhesives. One example is a simple paste made by cooking flour in water. Inorganic adhesives are mineral based adhesives such as silicate, Magnesia, phosphate and sulfur adhesives.

Despite the fact that organic adhesives have several positive characteristics such as (corrosion resistant characteristic and high firmness) their defect is that it is not easily affordable because of its high price. Another negative side of organic adhesives is that they are deficient substances on the market and they have lower resistance towards temperature more than 200 degree Celsius. Because of those negative sides of organic adhesive substances, it is important to introduce alternative binder material based on inorganic geopolymers, phosphate compounds and polymeric sulfur.

In the previous work there was presented results of our research. In this research we used phosphate compounds and polymeric sulfur as composite binder component. Phosphate compounds are provided as phosphoric acid salt. Despite the fact that it was obtained by using of simple methodology it has satisfactory adhesive characteristics. It is noticeable fact that we made glass/basalt based and phosphoric acid salt-based reinforcement material such as (fiber, discrete thread, grid). Based on this reinforcement material we have made composite and its characteristics is the same in some cases or less by (10-15%) compared to organic material based composite characteristics. Samples made from Phosphate compound and basalt fiber are shown on the figure below (fig. 1). It should be noted that reinforcement material made by us is highly resistant to fire and it has positive technical characteristics. According to internationally recognized standard -UL 94 our composite belongs to HB category.

Fig. 1 Basalt fiber reinforced Phosphate composite

Sulfur is a part of many composite but its potential in making sulfur concrete is not explored completely [3,4]. Out of many different types of sulfur based on its structure we are interested in polymeric sulfur that forms long chain and consists $10^4 \ldots 10^5$ atoms. Its molecular weight is approximately 18-70 thousand. Allotropic forms of sulfur can be obtained at different temperatures.

Temperature, ^{0}C	Allotropic form	Structure
95^{0}C	Rhombic	
120^{0}C	Monoclinic (needle like)	
160^{0}C	Cyclic	
180^{0}C	Polymeric	

It should be noted that, sulfur is able to bind mineral fillers. During hardening process of composite there does not form any internal stress. It should be noted that we have chosen its strengthening agent. Weight content of sulfur in the Sulfur Concrete is 12-15%. The andesite role in composite strength presented on the fig. 2.

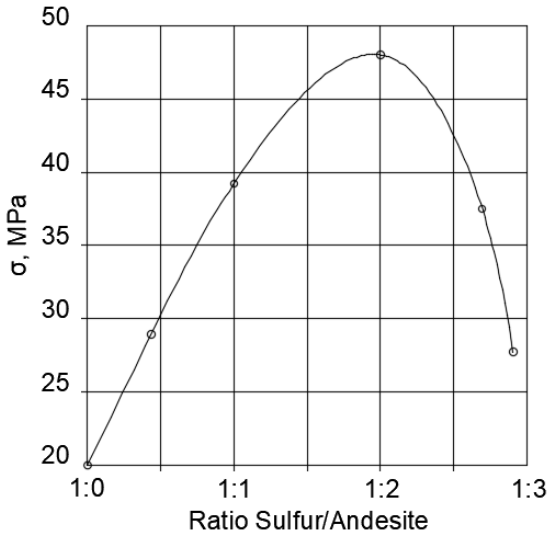


Fig. 2. Dependence of the compressive strength on the ratio Sulfur/Andesite

It is very interesting also sulfur based composite materials (sulfur concrete) and cement concrete comparative technical characteristics.

Characteristics	Sulfur concrete	Cement concrete
Density, kg/m^3	2400	2400
Adhesive expenses, kg/m^3	290	370
Strength while compressing, MPa	60	33,3
Strength while bending, MPa	9.1	3,72
Elasticity module, MPa	$39{,}1 \cdot 10^3$	$29{,}9 \cdot 10^3$
Note: both concrete is made by using of clean Granite		

Therefore, we have explored alternative adhesive materials such as phosphate compounds and polymeric sulfur and their using perspectives in our work. We have concluded that their use in our work is expedient. According to above mentioned information, when we are using organic adhesives and desired quantity is very high it is better to use alternative inorganic adhesives.

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