

# The use of polymer adhesives for the reconstruction of concrete elements of destroyed buildings in Libya

<sup>1</sup>Mouna Abdalhkem, Ukraine PhD Student, O.M. Beketov National University of Urban Economy in Kharkiv, Ukraine

*Abstract - The article examines the feasibility of application of polymeric adhesives for the reconstruction of destroyed buildings of concrete elements in the post-war Libya period. An analysis of the literature and the experience of the application of polymeric adhesives for repairing of buildings cracks, the acrylic polymer adhesives shows high efficiency.*

**Index Terms:** polymeric adhesives, reconstruction of Libya, cracks, acrylic glue.

## I. INTRODUCTION

The civil war in Libya It has become the largest number of victims in the conflict Arab Spring. The country suffered great economic losses, but low loss of Libya amounted to about \$ 14 billion. A lot of damage has been caused the country's infrastructure. Assessment of the country's infrastructure is characterized as sweaty and partial destruction of buildings [1] as shown in Figure 1.



Fig. 1. The destruction of buildings in Libya

The construction sector in Libya's pre-war period has grown steadily. In large cities are actively building monolithic high-rise buildings. After the war, a large part of the infrastructure built by the last decade destroyed. According to the Ministry of Housing and Utilities [2] in Libya is not necessary built a new infrastructure of the country because the existing destruction completely beyond repair. Damage to administrative structures. As well as residential areas, made of concrete and reinforced concrete elements have many cracks that modern construction is solved, one of these solutions is the use of polymer adhesives (Fig. 2).



Fig. 2. Repair of cracks of concrete and reinforced concrete elements by polymer adhesive

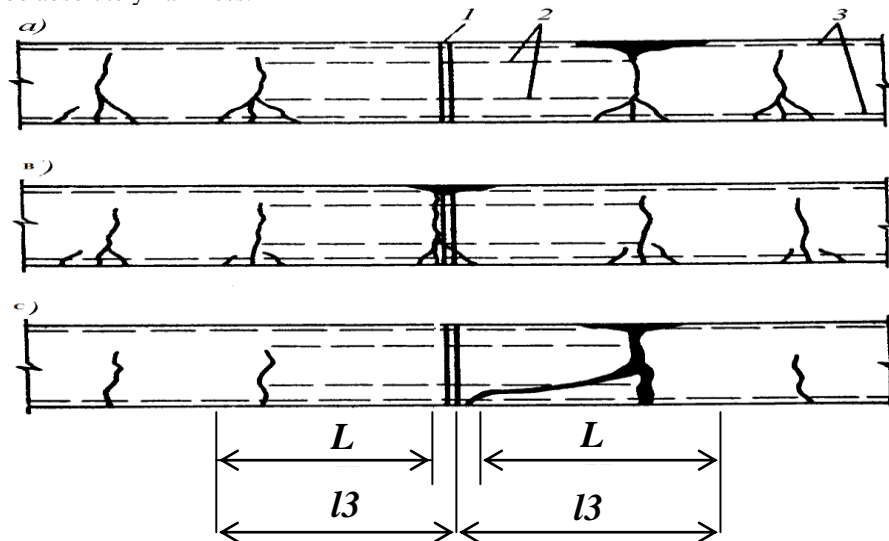
## II. MATERIALS AND METHODS

Polymer adhesives have a number of important properties: good adhesion to concrete and steel high mechanical strength, resistance to aggressive influences, good occupancy and the ability to create the glue seams of varying thickness, adjustable viability and fast curing properties of these compounds allow the creation of old concrete with an old, old concrete new, concrete and reinforced concrete prefabricated elements, etc. [3].

The solution of polymer adhesives application in concrete and reinforced concrete structures have been engaged many scientists: Pocius A.V. [9] Petrie E. M. [10], Skrypnyk O. [8], Morra M. [7], W. and others.

When bonding concrete and reinforced concrete polymeric adhesives needed to adhesives and glue joints meet the following basic requirements (Fig. 3):

- The adhesive and cohesive strength of the adhesive should be no lower than the strength of the connected concrete;
- linear expansion coefficient of the adhesive should be very close to the coefficient of linear expansion of the concrete;
- adhesive compound must be resistant to the operating environment and under these conditions provide the required durability;
- Process pot life (time of preparation of adhesive, within which it can be used for bonding) must correspond to the production requirements;
- Used in the adhesive composition of matter should have the lowest toxicity, and cured, the final state, the adhesive must be absolutely harmless.



**Fig. 3. Repair of bent reinforced concrete structural elements:**  
*a* - the destruction of the pile element: 1- glue line; 2 - pins;  
 3 - Longitudinal reinforcement; *b* - the destruction of the joint; *c* - on the joint

Experimental work [12]-[6]-[14] found that if all the production and technological and technical requirements of adhesive bonding old concrete to the old and impermeability ensures uniform strength of the joint. Extensive testing of these compounds confirm that adhesive joint strength, water resistance, cold resistance and superior weather resistance connection rendered monolithic cement composition (Fig. 4) [4]-[5].

However, the above applies only to the structures subject to short-term static loads. Work as adhesive joints under dynamic loads and long poorly understood [13]. However yet there is not sufficient research to analyze the durability of these materials in different conditions and their practical application to concrete bonding requires caution.

According to existing experimental and practical experience, for bonding concrete to concrete can be used polyvinyl acetate emulsion, synthetic latex and synthetic adhesives based on unsaturated polyester resins, epoxy (Table 1) [7].

For grouting structures may also be used coumarone-indene, polyurethane, phenol formaldehyde, phenol chloroprene, urea and other polymeric adhesives [9].



Fig.4. Adhesive joint of concrete structures elements

Table I: Physical and mechanical properties of acrylic and epoxy adhesives

Type of adhesive	Tensile strength, MPa			Module elasticity MPa	Poisson's ratio
	Compressive	at tension	at bending		
Acrylic	60 ... 90	16 ... 19	36 ... 41	(0.2 ... 1.6)·10 <sup>4</sup>	0.321 ... 0.21
Epoxy	50 ... 60	7 ... 9	35 ... 37	(0.15 ... 0.8)·10 <sup>4</sup>	0.34 ... 0.23

All of these adhesives have disadvantages: multicomponent have limited application temperature without additives and relatively high cost. In particular for epoxy adhesives require heating during kneading, from polyester - a small shelf life of (2 - 3 months), the introduction of mill ground fillers humidity should be no more than 2%. Most widely used epoxy and acrylic adhesives, as they are in their properties to meet all the requirements of the adhesives used to create reliable and durable connections of concrete and reinforced concrete elements as such compounds give the best results solidity [4]-[14].

From the analysis of the data [10]-[12] that an acrylic adhesive has the best indicators of the strength and deformability, as well as a broader range of their changes, which makes it possible to use them most effectively for the restoration and reconstruction of destroyed buildings in Libya. The acrylic adhesive is proposed to use to replace the currently used epoxy, silicone and other adhesives. The acrylic adhesive allows you to create a reliable, producible and relatively inexpensive compound concrete elements with savings of materials and reduction of labor costs for the repair, restoration or enhancement structure.

### III. CONCLUSIONS

Efficiency and feasibility of application of polymeric adhesives for the reconstruction of destroyed buildings Libya concrete elements requires a detailed study but based on the analyzed literature must conclude. What is the most effective is the use of acrylic adhesives. This issue requires further analysis and experimental studies.

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#### **AUTHOR BIOGRAPHY**



<sup>1</sup>**Mouna Abdalkhem**, PhD Student, Department of Civil Engineering, O.M. Beketov National University of Urban Economy in Kharkiv, Ukraine.

Author of 2 scientific publications. Research interests: reconstruction and mechanization of underground construction. KNUME, 61002, Ukraine, Kharkov, ul. Revolution, 12.