

elements. The method provides reliable forecasts for crack initiation and growth under a variety of loading conditions and can be used for structural assessment, planning of repair works and life-cycle management of concrete structures. Further work is recommended to expand the experimental database for different concrete classes and to integrate stochastic variability of material properties into probabilistic life predictions.

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#### STRENGTH INVESTIGATION OF ADGESIVE JOINTS BETWEEN CONCRETE AND STEEL

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**Relevance of the research.** The performance and reliability of composite concrete-steel structures are largely determined by the quality of adhesive joints between the materials. Failures in these joints can lead to localized cracking, detachment, or even catastrophic collapse, especially under dynamic or cyclic loads such as seismic events, wind, or repeated traffic vibrations. Modern engineering increasingly relies on composite structures for rehabilitation, retrofitting, and the construction of lightweight yet durable systems. Furthermore, the use of adhesives allows for more efficient load transfer, reduces stress concentrations, and enables innovative designs that traditional mechanical fastening cannot provide. Despite their advantages, the long-term behavior of adhesive joints under combined mechanical and environmental loads remains poorly understood. Therefore, the study of concrete-steel adhesive bonds is highly relevant for improving structural safety, optimizing material usage, and extending the service life of constructions [1-4].

**The purpose of the work.** The main objective of this research is to investigate the mechanical behavior, strength, and failure mechanisms of adhesive joints between concrete and steel. The study focuses on identifying the key factors that influence bond performance, including adhesive type, curing time, surface preparation, and joint geometry, and analyzing how these factors affect the response of the joints under tensile, shear, and combined loading conditions. The research also aims to establish correlations between experimental observations and predictive models for bond strength, providing practical guidance for structural engineers on the design and application of adhesive joints in concrete-steel composite systems. Ultimately, the work seeks to contribute to safer, more efficient, and durable solutions in modern civil engineering projects, enhancing the serviceability and longevity of structures [1, 2].

**Methodology and organization of the research** combines experimental testing, microscopic analysis, and statistical evaluation to ensure a comprehensive understanding of adhesive joint behavior. Concrete blocks of standard dimensions were cast, cured, and bonded with steel plates using different types of commercially available epoxy and polyurethane adhesives. Surface preparation techniques, including sandblasting, grinding, and cleaning, were applied to evaluate their influence on bond performance. After mechanical testing, fracture surfaces were examined using optical microscopy and scanning electron microscopy to identify failure modes, such as adhesive failure at the interface, cohesive failure within the adhesive layer, and substrate failure in the concrete. Experimental results were statistically analyzed to evaluate the influence of adhesive type, joint thickness, and curing conditions. This methodology allowed for a systematic assessment of mechanical and material factors affecting adhesive joint behavior under realistic loading conditions [1, 2].

**The results of the research.** The study demonstrated that adhesive type, surface preparation, and curing time significantly affect the mechanical behavior of concrete-steel joints. Epoxy adhesives exhibited superior tensile and shear strength compared to polyurethane adhesives, with higher stiffness and better durability under cyclic loads. Increased surface roughness and proper cleaning improved the effective bond area, enhanced load transfer, and delayed the onset of cracking. Failure modes were classified as adhesive failure at the interface, cohesive failure within the adhesive, and substrate failure in the concrete, with their prevalence dependent on adhesive type and preparation method. Statistical analysis confirmed strong correlations between adhesive properties, joint thickness, and measured strength. Predictive models developed in this study accurately estimate the ultimate load capacity of adhesive joints and can serve as reliable tools for the design, assessment, and optimization of concrete-steel composite structures. The results provide clear evidence that proper joint design and material selection significantly improve structural performance and safety [1,2].

**Conclusion.** The research confirms that careful selection of adhesive materials, proper surface preparation, and optimized curing conditions significantly enhance the strength and durability of concrete-steel adhesive joints. Adhesive bonding proves to be an effective method for transferring loads in composite structures, reducing stress concentrations, and extending service life. The findings provide valuable guidance for the design, construction, and retrofitting of reinforced concrete structures, ensuring higher safety, reliability, and long-term performance. Future research may focus on long-term durability under environmental exposure and dynamic loading, as well as the integration of numerical modeling for design optimization.

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