ASEC 2025 Conference
The 6th International Electronic Conference on Applied Sciences
09–11 December 2025 | Online
MDPI

Ensuring the Composite Action of Steel and Concrete Using Multicomponent Composite Materials

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INTRODUCTION & AIM

Steel-reinforced concrete is an integral part of construction, but its durability and reliability can be compromised by problems arising from the interaction between steel and concrete. Differences in the properties of these materials, such as thermal expansion coefficient, shrinkage, and modulus of elasticity, often lead to microcracking, reduced load-bearing capacity, increased corrosion, adhesion problems, and a shorter service life for structures.

The main aim of the study is to investigate the effectiveness of multicomponent composite materials that improve the interaction between steel and concrete by modifying the interface layer, strengthening the adhesive strength, and protecting permanent formwork from corrosion.

METHOD

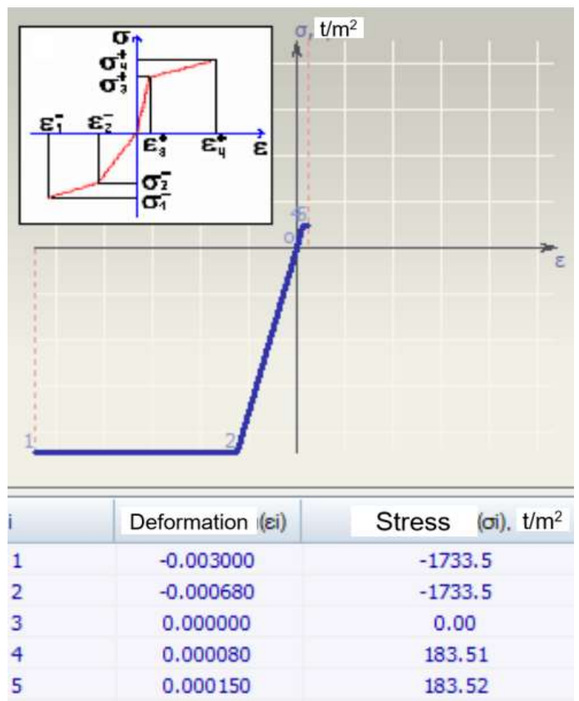
The study was conducted in two stages. First, we selected materials, among which were: acrylic polymer compositions; epoxy resins with modified hardeners; liquid glass-based materials with mineral fillers; hybrid organo-mineral systems.

In the second stage, experimental tests were conducted, which included assessment of adhesive strength, corrosion resistance, crack resistance, and durability under cyclic freezing/thawing conditions.

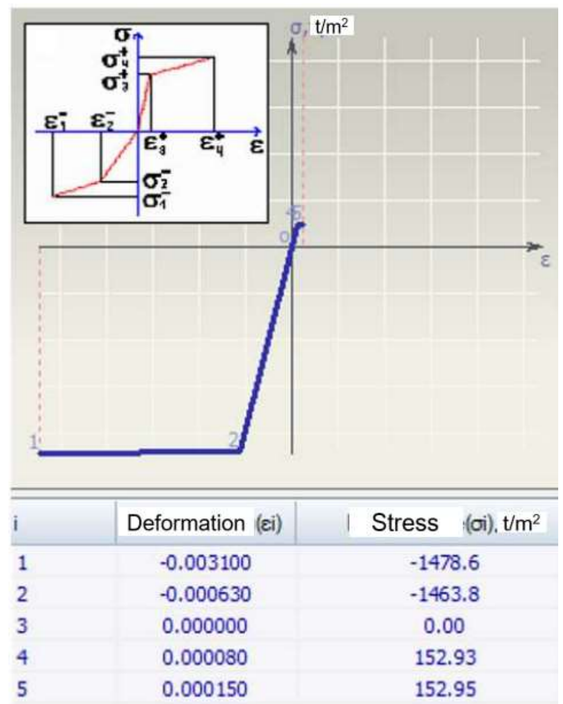
Name of characteristic	t = 4 mm		t =6 mm		t =8 mm	
	Meaning	Δ, %	Meaning	Δ, %	Meaning	Δ, %
Normal stress in compressed reinforcement σ_{com}, t/m^2	-13770	100	-13885	100,84	-14074	102,21
The same, but in stretched reinforcement σ_s, t/m^2	24473	100	24473	100	24473	100
Maximum deformation of compressed reinforcement, ε_{com}	-0,000983	100	-0,000992	100,92	-0,001005	102,24
The same, but in stretched reinforcement ε_s	0,0254	100	0,01937	76,26	0,01946	76,61
Compressed reinforcement deformation module E_{com}, t/m^2	1,4e7	100	1,4e7	100	1,4e7	100
Strain module of tensile reinforcement, E_s, t/m^2	9,63e5	100	1,263e6	131,2	1,258e6	130,6

RESULTS & DISCUSSION

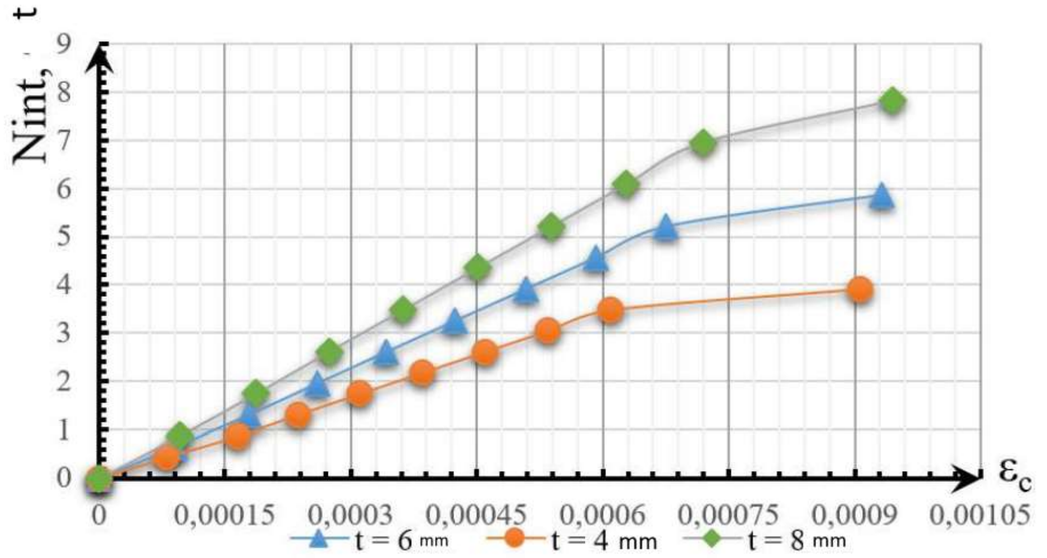
The results obtained demonstrate a significant improvement in the compatibility of steel and concrete through the use of multicomponent composite materials. In particular, the adhesive strength increased by 20-40% compared to unmodified samples, indicating the formation of a denser and more homogeneous structure at the interface. Multicomponent composite materials also provided effective protection for reinforcement, reducing the corrosion rate in aggressive environments by 50% or more. The polymer components in the multicomponent composite materials matrix partially compensated for the stresses caused by differences in the thermal expansion of materials, reducing the risk of microcracking.



i	Deformation (εi)	Stress (σi), t/m²
1	-0.003000	-1733.5
2	-0.000680	-1733.5
3	0.000000	0.00
4	0.000080	183.51
5	0.000150	183.52



i	Deformation (εi)	Stress (σi), t/m²
1	-0.003100	-1478.6
2	-0.000630	-1463.8
3	0.000000	0.00
4	0.000080	152.93
5	0.000150	152.95



CONCLUSION

The results of the study confirm that multicomponent composite materials are an effective solution for ensuring the compatibility of steel and concrete. Epoxy and hybrid composites are particularly promising, which demonstrate high adhesion, resistance to cracking, temperature changes and durability. The prospects of using such materials in construction will significantly increase the reliability of structures and extend their service life.

The technology for implementing such materials opens up opportunities for the creation of modern construction projects that are not only highly efficient and durable, but also meet safety and sustainability requirements.

FUTURE WORK / REFERENCES

Future research should focus on the long-term performance of multicomponent composite materials under real environmental conditions. Further studies are also needed to optimize the composition for different construction applications and to assess the environmental impact and sustainability of these materials. Investigating their behavior under dynamic and seismic loads could provide valuable insights for critical infrastructure design.