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使用水泥悬浮液作为纺织品加固混凝土的替代基体材料

托马斯·雷普卡，马雷克·莫泽尔，雅库布·弗斯特
捷克共和国节能建筑部

摘 要：纺织品加固混凝土（TRC）是一种由高性能混凝土（HPC）和碳纤维绳（拉伸钢筋与环氧树脂基体）组成的材料。然而，在较高温度下，环氧树脂的耐受性低的问题仍然存在。在这项工作中，本研究评估了环氧树脂基体的替代物，一种不可燃的水泥悬浮液（水泥乳），它已被证明在高温下具有稳定性。在工作的第一部分，本研究进行了显微镜研究以确定水泥悬浮液中的颗粒大小分布。随后，作者设计并制备了五个系列的板状样品，这些样品在水泥的类型和纺织物加固的饱和方法上有所不同。随后，本研究进行了机械实验（四点弯曲试验）以验证每种类型样品的性能。结果发现，使用较细的水泥（CEM 52.5）和压力饱和方法，碳纤维粗纱的饱和效率最高。此外，这种方案在四点弯曲试验中也表现出最好的结果。最后，在水泥基体中使用 CEM52.5 似乎是 TRC 建筑的一个可行的变体，可以克服其耐低温的问题。

关键词：品加固混凝土；水泥悬浮液；碳纤维

Use of Cement Suspension as an Alternative Matrix Material for Textile-Reinforced Concrete

Tomas Repka, Marek Mozer, Jakub Furst
Department of Energy Efficient Buildings, Czech Republic

Abstract Textile-reinforced concrete (TRC) is a material consisting of high-performance concrete (HPC) and tensile reinforcement comprised of carbon roving with epoxy resin matrix. However, the problem of low epoxy resin resistance at higher temperatures persists. In this work, an alternative to the epoxy resin matrix, a non-combustible cement suspension (cement milk) which has proven stability at elevated temperatures, was evaluated. In the first part of the work, microscopic research was carried out to determine the distribution of particle sizes in the cement suspension. Subsequently, five series of plate samples differing in the type of cement and the method of textile reinforcement saturation were designed and prepared. Mechanical experiments (four-point bending tests) were carried out to verify the properties of each sample type. It was found that the highest efficiency of carbon roving saturation was achieved by using finer ground cement (CEM 52.5) and the pressure saturation method. Moreover, this solution also exhibited the best results in the four-point bending test. Finally, the use of CEM 52.5 in the cement matrix appears to be a feasible variant for TRC constructions that could overcome problems with its low temperature resistance.

Keywords Textile-reinforced concrete; Cement suspension; Carbon fibers

引言

/

Colombo

TRC 20

TRC

Heimbs TRC

Shams

TRC TRC

Gopinath TRC

TRC Raj HPC

TRC

Cuypers

Kavianiboroujeni

TRC

TRC

TRC

TRC

TRC

TRC

700◦C

TRC

SiO2

A CEM42.5R-

B CEM 52.5 R-

C CEM 42.5 R-

D CEM 52.5 R-

E

结果

1.

CEM 42.5 R CEM 52.5 R

30

CEM42,5

20000

CEM 52.5 R CEM 42.5 R

CEM 52.5 R 301.5 μm2 CEM 42.5 R 397.8 μm2 CEM 42.5 R

2.

TRC

A-E

8 40

HPC

TRC

CTU UCEEB

HPC

CEM 52.5 R

C-E

A-E

A B

B

E

讨论和结论

20◦C

9 CEM 52.5 R 12 CEM 42.5 R HPC

7-10 μm

A B

CEM 52.5 R C D Epoxy 1 2

3 E

CEM 42.5 R 22%

C D 9%

μm

CEM 52.5 R CEM 42.5 R 2.3

3.

>7

CEM52.5R

CEM42.5R

CEM42.5R 1000μm2

2.0

1.1 1.6

CEM 52.5 R

B

4.7

100mm × 360mm × 18mm

A B 8mm × 8mm × 100mm

A B 28% CEM 52.5 R

A B 4-5 B 67%

A 1.62 B A 45%

1.63 A3 C 36% D 46%

1.35 B E

A 17%

A B 21% C
D 9% ISO 834

CEM42.5R CEM52.5R

E

C D

C D

C D
A B

A B

CEM 52.5 R

B
B 30%
100% B

1

TRC

A
B

参考文献

1. Hegger J, Schneider H, Sherif A, et al. Exterior Cladding Panels as An Application of Textile Reinforced Concrete. ACI Symp. Publ. 2004; 224: 55–70.
2. Chira A, Kumar A, Vlach T, et al. Textile-reinforced concrete facade panels with rigid foam core prisms. J. Sandw. Struct. Mater. 2016; 18: 200–214.
3. Laiblová L, Pešta P, Kumar A, et al. Environmental Impact of Textile Reinforced Concrete Facades Compared to Conventional Solutions—LCA Case Study. Materials 2019; 12: 3194.
4. Repka J, Vlach T, Laiblov ˇ á L, et al. Thin Lightweight Panels Made of Textile Reinforced Concrete. Solid State Phenom. 2017; 259: 238–243.
5. Peled A, Bentur A, Mobasher B. Textile Reinforced Concrete; CRC Press: Boca Raton, FL, USA, 2019; ISBN 978-1-351-64546-1.
6. Hegger J, Will N, Bruckermann O, et al. Load-bearing behaviour and simulation of textile reinforced concrete. Mater. Struct. 2006; 39: 765–776.
7. de Andrade Silva F, Butler M, Hempel S, et al. Effects of elevated temperatures on the interface properties of carbon textile-reinforced concrete. Cem. Concr. Compos. 2014; 48: 26–34.
8. Foreman JP, Porter D, Behzadi S, et al. Predicting the thermomechanical properties of an epoxy resin blend as a function of temperature and strain rate. Compos. Part A Appl. Sci. Manuf. 2010; 41: 1072–1076.
9. Brameshuber W. Textile reinforced concrete-state-of-the-art report of RILEM TC 201-TRC. In Reunion Internationale des Laboratoires et Experts des Materiaux, Systemes de Construction et Ouvrages (RILEM); RILEM Publications SARL: Paris, France, 2006; ISBN 2- 912143-99-3.