Global Journals LaTeX JournalKaleidoscope™
Artificial Intelligence formulated this projection for compatibility purposes from the original article published at Global Journals. However, this technology is currently in beta. *Therefore, kindly ignore odd layouts, missed formulae, text, tables, or figures.*

CrossRef DOI of original article:

Efficiency of Self-Healing Cementing Materials

Xiao Xinyuan

Received: 1 January 1970 Accepted: 1 January 1970 Published: 1 January 1970

Abstract

In order to meet the special requirements (for the strength and conductivity of concrete structures) that arise during the transmission of electricity to remote areas of the Russian Federation, a variant of using self-healing concrete is proposed. In this material, it is proposed to use microcapsules obtained by the physical method, consisting of sodium silicate and bentonite clay coated with ethyl cellulose with graphene. The mechanism of action of the capsule is as follows: after external mechanical destruction, access to graphene appears and it acts as a conductive medium, resulting in the cementing properties of the capsule core. In the course of the work, the optimal ratio of graphene and the capsule core was established, which was determined during a number of experiments and microstructure studies. The dependences of the compressive strength and conductivity of the composite on the graphene content in the capsule, the number of microcapsules in concrete and the time of strength gain were also revealed. In the experiments, the average size of microcapsules was 1.25 mm, the grain shape is predominantly spherical with a rough surface and dense structure. The optimal microcapsule content was 2

Index terms— graphene; microcapsules; self-healing cementing materials, compressive strength; conductivity.

1 ?????????

[11]

. ??????? ???????????? ????? ?????? ???????? ?? ?????????? [12][13][14], ?????????? [15], ??????-?????????? [16][17][18][19][20][21] ? ?????? ??????? (????. 1). ?? Ð?"????? [22] ???? ???? BS SiO??M ? bc (â??")??(â??") ? f cf (â??")?K(?) ????? ????????? ? ???????????????? SS G ? bc (â??")?f cf (?) ? K(?)

???????????? ????? ???????? PER?SS? DCPD?MMA? CS UF?PU?PUF? PS?PF?MF ? bc (â??") ?f cf (â??") ? E(?)?K(?

2 II. ???????????? ???????? ?????????? ?????????, ??????????? ? ???????? ?? ????????

Ð?"?? ???????????? ???????? ?????????? ????????? ??? ?????? ?????? ?????? : ????? = 1 : 3 ? ????????????? ???????????? 06. ?????????? ? ?????????? ??????????? ? ??? ?????????? 1, 2, 3, 4 ? 5%, ??????? ??????????? ?????? ? ?????????? 15 % ?? ????? ??????????? ? ??????? ?????? ??????? ? ?????????? 0,025; 0,05; 0,1; 0,25 ? 0,5 % ?? ????? ??????. ?? ???????????? ? ???????????????? ???????? ????????? ?????????? ????????????? ???????-???? ???????? 70×70×70 ?? ? ????? 7, 14 ? 28 ????? ????????? ????????? ?? ????????? ?? ??????????? ??????? ????????? ??? ?????? ? ?????????? ???????? ????????????? ????????? ??? ????????? ????????? ????? ????????????? ? ????????? ??????????? ????????.

?????????? ????????????? ???? ????????????, ??? ???? ??????? ??????, ????????????????????? ?????????, ???????? ? ????????????? ????? ? ??????????? 25, 30, 10 ? 2 % ????????????? ? ???????????? ?? ???????????? ? ????? ????????? (???.2). ????? ????????? 29% ???????????????? ???? ? 4% Tween 80 ? ???????????? ??? ??????????? 40°C. ?? ?????????? ????? ??????? ????????? ? ??????????? ???????????

???????? ???????. ???????? ???????? ?? ?????????????, ????????? ?????? ? ??????? (10, 18 ? 72% ??????????????) ????? ??????????? ????????????? ??????? ?? ??????????? ??????. ???? ??????? ??????????? ? ????????? ?????? ? ????????????? ???????????????. Ð?"?? ?????????? ????????????? ???????? ??????? ????????? ??????? ???????? 1-1,25 ??. ??? ??????????? ?????????? ?????????? ?????? ???????????????? ????? ?????? ????????? ?????? ?????????????, ? ??????? ?? ????? ???????? ??????????????, ??? ??????? ? ??????????? ????????? ????????? ??????.

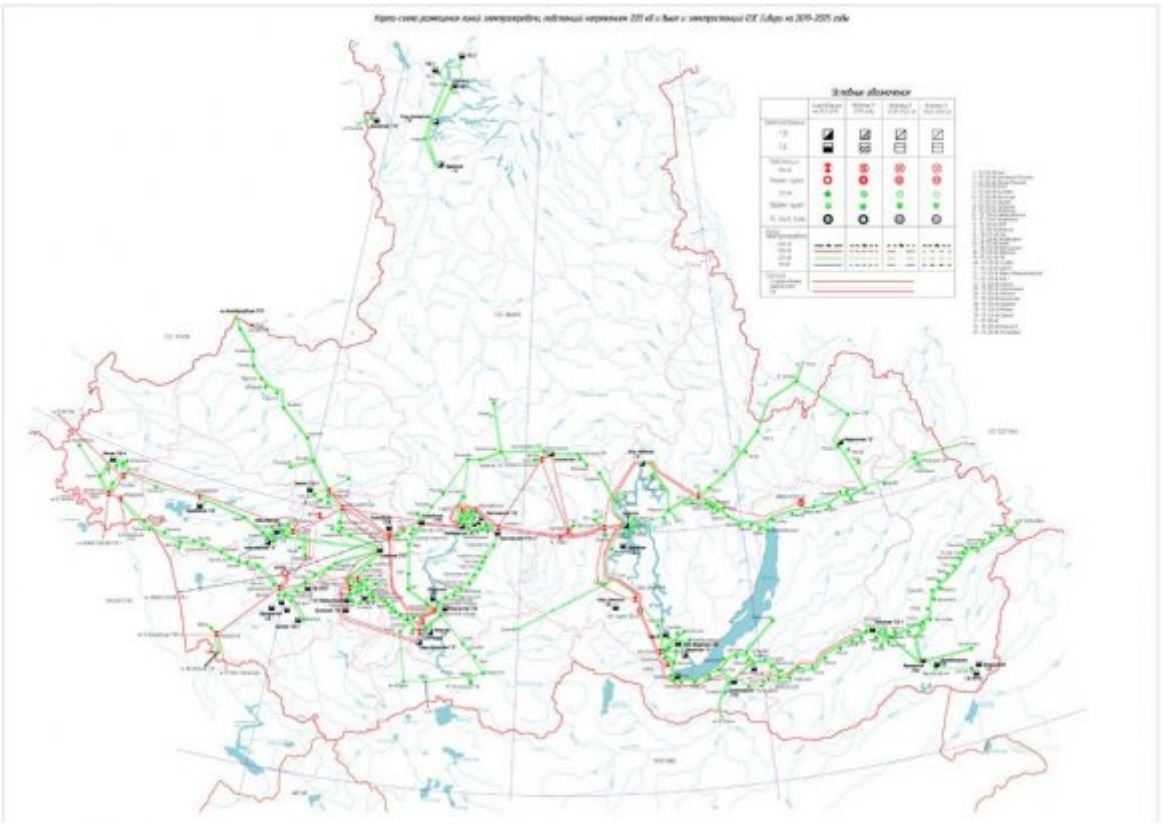
3 ???. 2: ????? ??????????? ???????????

% 100 K K K K K 1 0 1 2 x × - - = (3) % 100 K K K 0 2 h × = (4)

????????????? ????????????????? ?????????????????, ??????? ????????? ????????? ?????????? ????????????? ????? ?????? ????????? ? ????????? ??????????, ??????? ???????????????? ??????. ????????? ?? ??????????? ????? ?????????? ??????????? ?? ??????? ?? ?????????? 20 ?? ???? ?? ????? (???.4), ?????????? ???????? ??????????? ????, ????????? (I) ? ????????? (U). ??? ?????????? ?????????? ??????? ? ?????????, ????????? ?????? ????????? ?????????? ?? ??????? ? 0,1% ??????? ? ????????? ???????? 121,6% ?? ???????????? (???. 9). Ð?"????????? ?????????? ???? ??????? ???????? ? ?????????? ????????? ? ??? ?????????? 0,5% ????? ????? ????????? ?? ?????? ????? 92%. ?????????? ?????????? ??????????? ???, ??? ?????? ??? ????????? ?????????? ???????? ???????? ?????????? ???????, ????????? ??????? ?? ???????????, ? ????? ???????? ????????? ????????? ??????????.

4 ???. 4: ??????? ???????? ?????? ?????????????

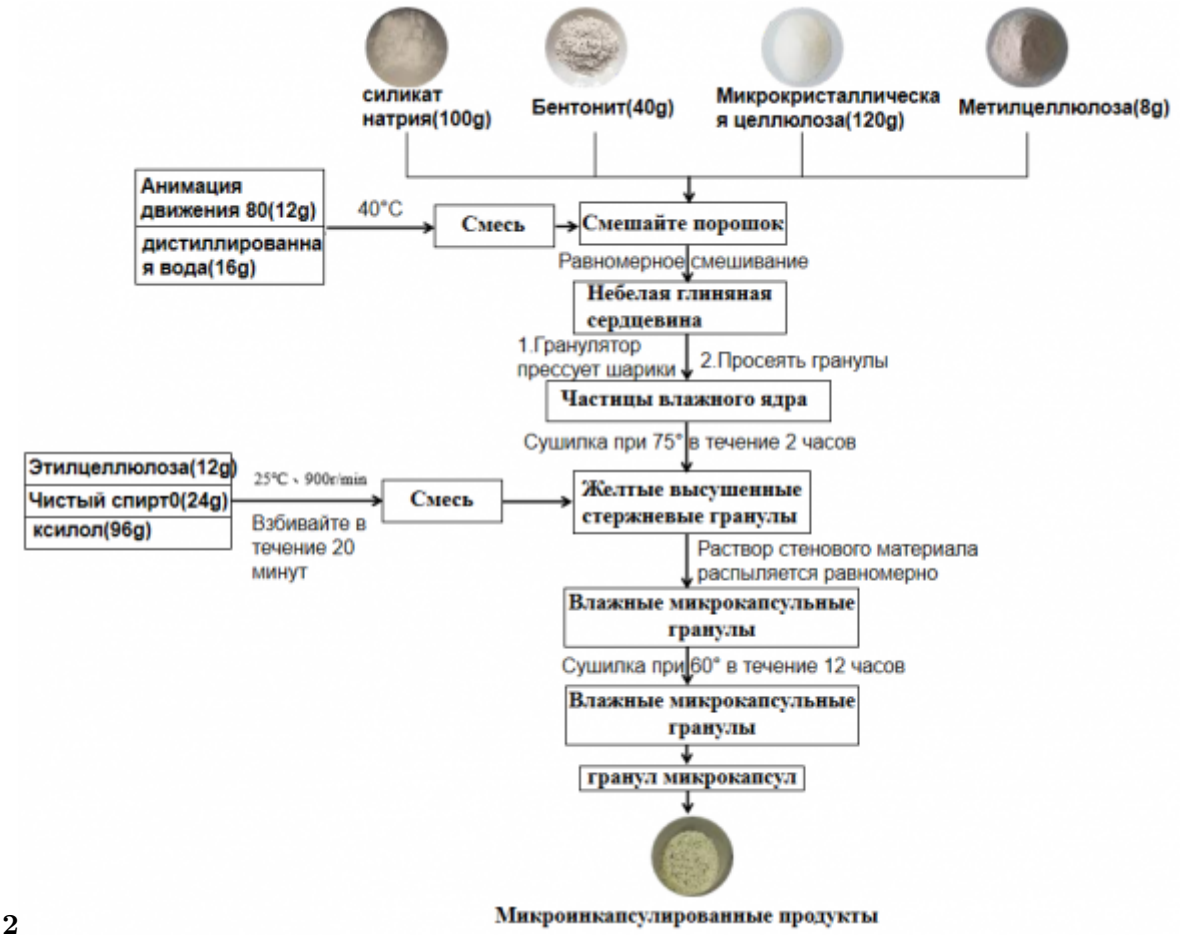
 ???. 9: ????????? ?? ?????? 28-???????? ???????? [1]



1

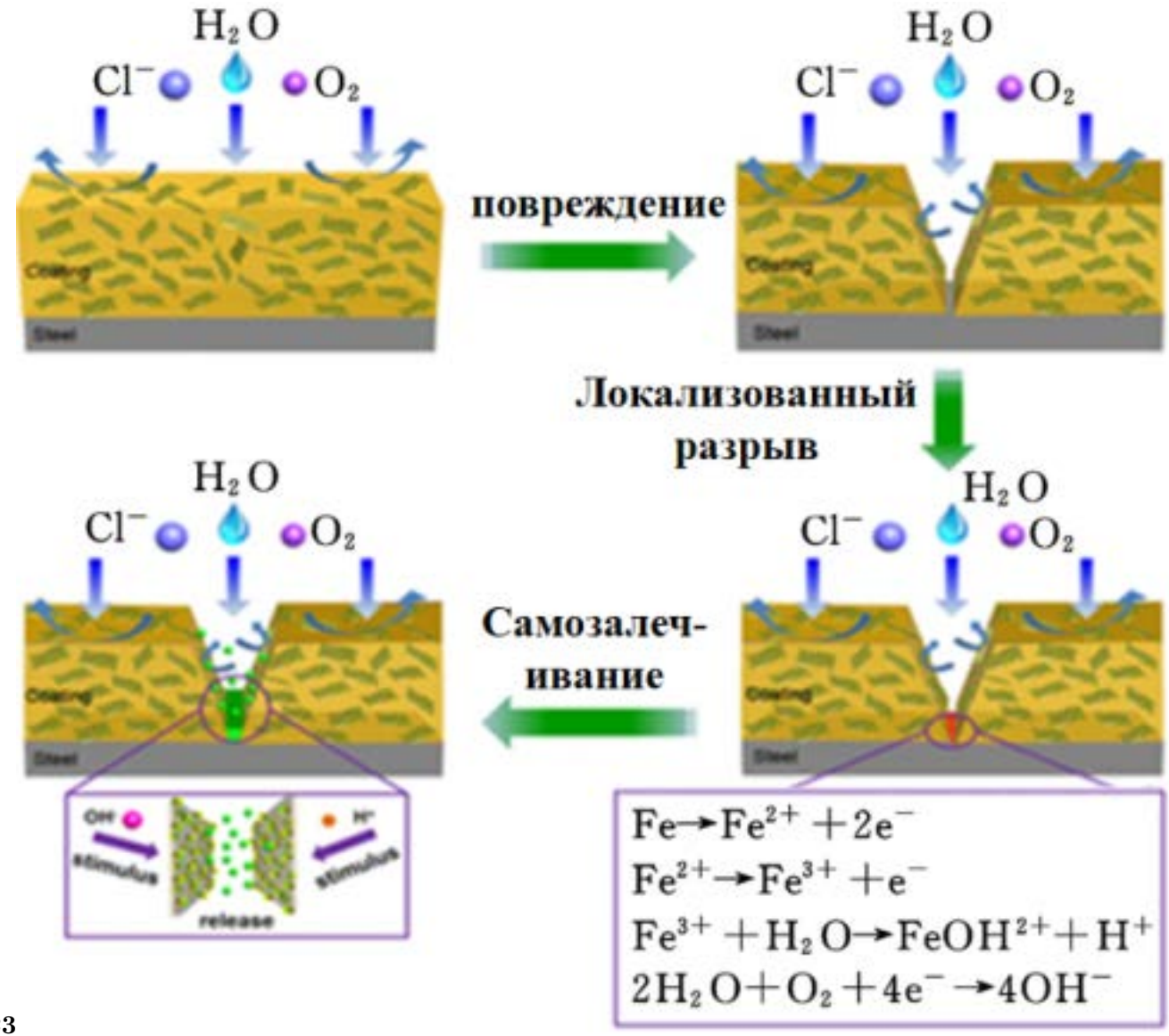
Figure 1: Fig. 1 :

[1] Year 2023 Efficiency of Self-Healing Cementing Materials



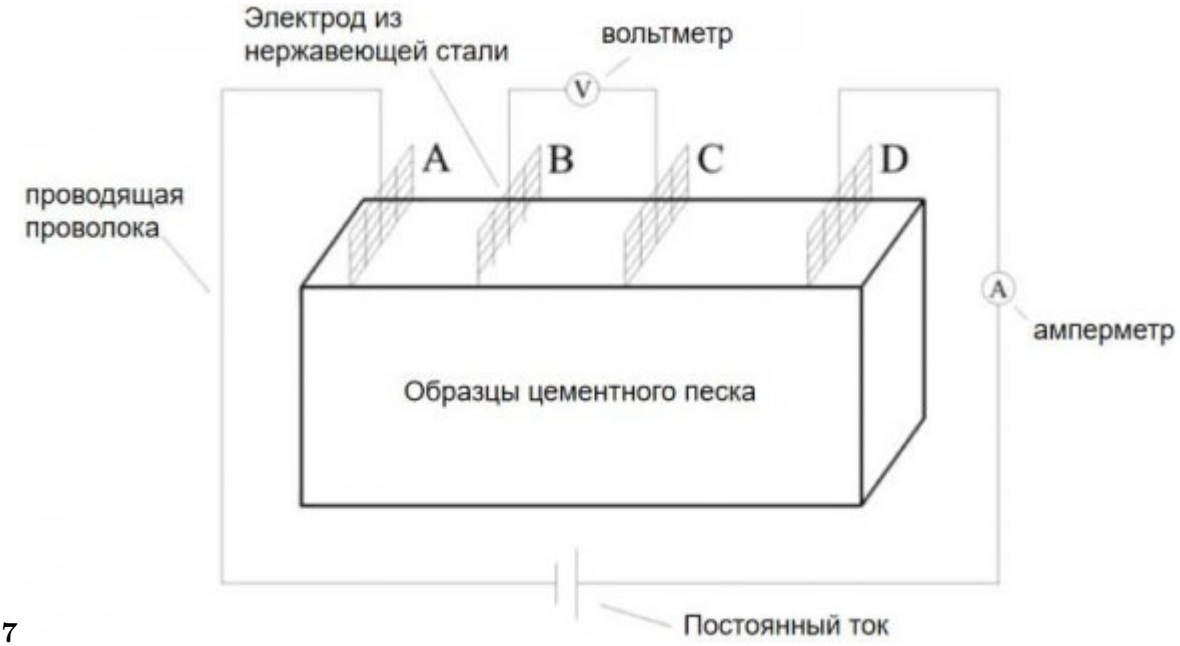
2

Figure 2: Fig. 2 :



23

Figure 3: 2Na 2 ?Fig. 3 :



4567

Figure 4: Fig. 4 :Fig. 5 :Fig. 6 :Fig. 7 :

8

Figure 5: Fig. 8 :

910

Figure 6: Fig. 9 :Fig. 10 :

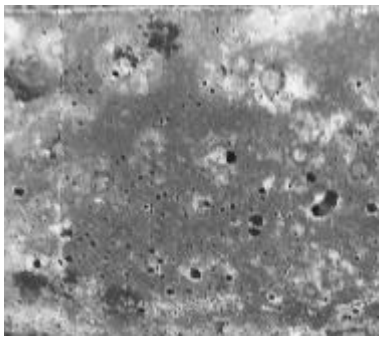


Figure 7:

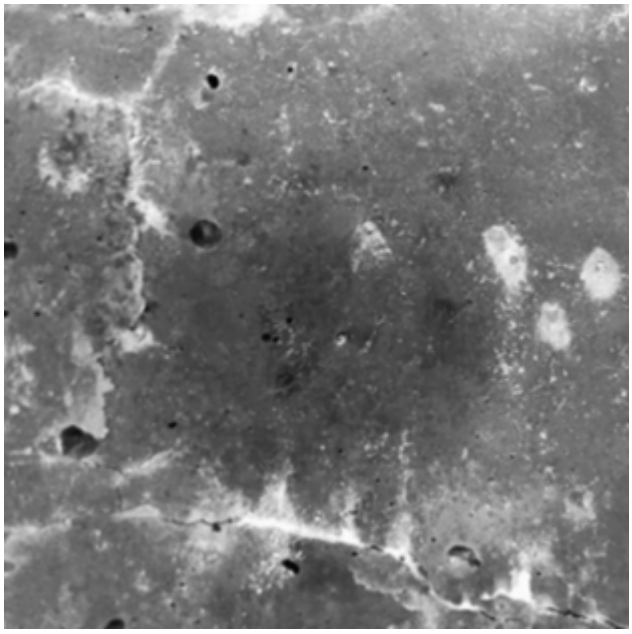


Figure 8:

????????? ???????????? ????????????
????????????, ?????????? ?????????? ???????,
?????????

Figure 9: -? ????? ?????????????? ?????????? ?????????? (?? ????????? ? ???????????
???????? ??????????), ??????? ????????? ??? ???????? ????????????? ? ?????????? ??????
?? ????????? ??????? ?????????? ?????????????????????? ??????. ? ????

???????? 1,25 ??, ????? ?????
??????????????? ?????????? ? ??????????
??????????? ? ??????? ??????????. ???????????
?????????? ?????????? ????????? 2% ?? ?????
?????????? ????????, ??? ????????????? 0,1% ??????
???????. ??? ?????????? ?????????? ???????
??????????? ?????????

Figure 10: ?? ???????? ?????? ? ???????????? ????? ???????? ????????? ?? ????????????
? ????????. ???????? ???????? ??????? ?????????: ????? ???????? ???????????? ??????????
?????????? ?????? ? ??????? ? ?? ????????? ? ???????? ?????????? ????? ? ?????????? ????
?????????? ????????????? ???????? ???? ???????. ? ???? ?????? ?????????? ??????????
?????????? ??????? ? ???? ??????, ??????? ???????????? ? ???? ???? ?????????????
? ????????????? ?????????????. ????? ???????? ?????????? ????????? ?? ?????? ?
???????????? ????????? ?? ?????????? ??????? ? ???????, ?????????? ?????????? ? ?????? ?
??????? ?????? ??????????. ? ????????????? ??????? ?????? ??????????

????????	?????: ??????;????????????;
?????????????????????	?????????????
?????????, ????????? ?? ??????; ????????????.	

Figure 11: ????????? ????????? ??????????, ? ????????? ?? ?????? ?? ????????? ??????? ??????????, ? ????? ?????????. ????? ?????????? ????????? ???????? (????????? ??????????) ?? ?????????? ?????????? ???????? ????????????, ??? ???? ?????????? ????????????? ???????? 81%, ? ?????????? ????????????? ????????? ?? ?????? -57%.

1

, ???? ??? [23], ??? ??? [24], ??
??????? [25], ?. ???? [26] ? ?????? ?????????
???????????????? ???????????? ? ??????????????
????????????? ? ??????? ??????????, ?????????

Figure 12: Table 1 :

?????????:

????????? ????????: E: ?????? ?????????, Ed:
???????????? ?????? ?????????, Cr: ???????? ????????,
K: ???????? ?????????? ??????, BS: ?????????????
?????, MA: ????????, G: ???????, PER: ??????????
?????, AE: ???????, CH: ????????? ???????, CS:
??????????, CSA: ??????????? ???????, DCPD:
???????????????, EC: ???????????????,M: ???????,
MF: ???????????????, MFP: ??????????????, F:
????????????????, PS: ??????????, PU: ??????????,
PVA: ????????????? ?????, SF: ?????????? ??????,
SS: ??????? ??????, UF: ??????????????????????.
? ?? ?? ?????, ?????????? ?????????
?????????? ? ??????????? ???? ??? ?????????
??????? ? ????????? ??????. ???????? ????? ? ????????
??? ????????? ?????????? ??????? ?????? ??????????
????????????? ?????????? ?????, ????? ??? ??????,
?????????? ???????, ???????? ????, ???????? ??????? ?
?????????? ???????. ???????????? ??????? (?
??????? ????????????? ? ??????? ????????
???????????) ????????? ?????????? ????????
???????????????????? ???????? ??????????, ??????
??????? ?????????? ????????????? ????????? ?
?????????? ??? ?????????????, ??? ???????????? ???
??????????. ??? ????, ????? ????????, ??? ? ??????
????????????? ?????????? ????????? ?????? ??
?????????????? ???????? ???????? ??????. ???????
?????????? ??????????, ??? ??????? ???????
???????-???????????????? ??????? ?????? ?????????
??? ????????????? ? ????????????? ??? ? ?????? ? ??
??????-?????? ?????.
? ????????????? ??????????? ??????
?????????????

???????????? ? ??????? ?????

????????????

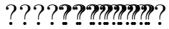


Figure 13:

Efficiency of Self-Healing Cementing Materials
??????????, ??????????? ????? ? ???????????? ????????? ??? ???????????? ????? ??????????? ???????????. ????? ????????????? ???????? ???????? ???? ??????? ????????????? ? ??? ???????? ??????? ?????????? ? ????????, ???????? ?? ? ??? ????? ??????????. 2. ???????? ??????????? ?? 1% ???????? ????????? ?? ??????, ?????? ??? ?????????? ?????????? 23. ZHANG Ming. microcapsules and their binary self-healing ???? ??????????? ????????? ????????? ????????? materials[D]. Harbin Institute of Technology, 2012.)
? ??? ?????????? 3,0% ??? ??????????? ???? 26. LYU Zhong, XIONG Tingqian, CHEN Huisu.
???????????? ???????. ????????????? ?????????? Numerical simulation of repair efficiency of
??????????? ?????????? 2%, ??? ???? ??????????? spherical/spherical microcapsule self-healing
Global Journal of Researches in Engineering ( ) E Volume Xx XIII Issue II V I 20 Year 2023 ( ) E Volume Xx XIII Issue II V ersion I 22 cementitious composites[J]. Global Journal of Researches in Engineering ?????????? ????????? ??????????????????????? ???????. ?? 3. ???????? ? ?????????? ?????? ??????? ??????? ?????? ? ???????? ????????? ??????, ? ????? ???????. ??????????? ?????????? ?????? ??????? ? ???????? ?????????? ?????????? ?? 0,05 ?? 0,15%, ??? ????????? ???????? ????? ???????????? ?????? ????????????. 4. Đ?”????????? ?????? ??????? ???????? ???????????? ?????????? ??????, ??????????? ?????????? ?????????? 0,1%: ???? ????? ?????? ?????? ???????? ????????????, ? ?????????? ?? ???????? ?????? ????????????? ? ? ?????? ????????? ????????? ???????? ???????????? ???????????????. Year 2023

1. ????????????? ???????????? ?????????? ??????? ?????? ? ???????? ? ?????????? ?????????? ??????? ????? ???????? ?????????????

(???????? ????????????? ?????

Figure 14:

[Dong Xufeng et al. ()] 'Effect of particle size distribution on properties of resinbased magnetostrictive composites'. Dong Xufeng , Guan Xinchun , Jinping . *AMCS* 2010. 27 (02) p. .

[Zhu Kangjie et al. ()] 'Effects of size and content of microcapsule repair agent on release rate of microbial self-healing concrete[J]'. Zhu Kangjie , Chunxiang , Li Min . *Materials Reports* 2020. 34 (S2) p. .

[Bergman and Wudl ()] 'Mendable polymers[J]'. D Bergman , F Wudl . *Journal of Materials Chemistry* 2007. 18 (1) p. .

[Wang Xingang et al. ()] 'Particle characteristics and sustained release performance of epoxy resin/ethylcellulose microcapsules[J]'. Wang Xingang , Long , Fu Xingguo . *Journal of Building Materials* 2020. 23 (02) p. .

[Dong et al. ()] *Performance recovery concerning the permeability of concrete by means of a microcapsule based self-healing system[J]. Cement and Concrete Composites*, B Q Dong , G H Fang , Y H Wang . 2017. 78 p. .

[Tigang et al. ()] 'Preparation and corrosion resistance of Q235/Ni-Cobased self-healing coating[J]'. Duan Tigang , Huang Guosheng , Ma Li . *Chinese Journal of Materials Research* 2020. 34 (10) p. .

[Tigang et al. ()] 'Preparation and corrosion resistance of Q235/Ni-Cobased self-healing coating[J]'. Duan Tigang , Huang Guosheng , Ma Li . *Chinese Journal of Materials Research* 2020. 34 (10) p. .

[Yan Ying et al. ()] 'Preparation and performance of self-healing microcapsules[J]'. Yan Ying , Yongping , Zhang Huiping . *Journal of Chemical Engineering of Chinese Universities* 2011. 25 (03) p. .

[Xing Ruiying et al. ()] 'Preparation of reactive vinyl silicone oil/polyurea formaldehyde self-healing microcapsule'. Xing Ruiying , Zhang Qiuyu , Qiushi . *Materials Reports* 2009. 23 (10) p. .

[Yang Guokun et al. ()] 'Preparation of temperature-controlled self-healing microcapsules and their application in cementing cement slurry in hydrate formation[J]'. Yang Guokun , Jiang Guosheng , Liu Tianle . *Materials Reports* 2021. 35 (02) p. .

[Zhang et al. ()] 'Properties of percolation structure of self-healing cementitious composites based on UF/E microcapsule[J]'. M Zhang , L Chen , F Xing . *Journal of Building Materials* 2014. 17 (4) p. .

[Zhang Peng et al. ()] 'Research and progress of self-repair technology for concrete damage'. Zhang Peng , Chen Jingjing , Wei . *Materials Reports* 2018. 32 (19) p. .

[Dang Xudan et al. ()] 'Research on capsule-type self-healing intelligent composites[J]'. Dang Xudan , Heng , He Yuejin . *Materials Reports* 2005. 4 (01) p. .

[Ou Jinping et al. ()] 'Research progress of stress self-sensing cementitious composites and their sensors[J]'. Ou Jinping , L I Guan Xinchun , Hui . *Journal of Composites* 2006. 4 (04) p. .

[Zhong and Huisu ()] 'Research progress on autonomous healing of cracks in cement-based materials[J]'. Chen Zhong , Huisu . *Journal of the Chinese Ceramic Society* 2014. 42 (02) p. .

[Li ()] 'Robust Self-Healing Concrete for Sustainable Infrastructure[J]'. V C Li , EmilyH . *ACT* 2012. 10 (6) p. .

[Lili et al. ()] 'Self-healing process and products of engineering cementitious composites[J]'. Kan Lili , Shi Huisheng , Qu Guangfei . *Journal of Tongji University (Natural Science Edition)* 2011. 39 (10) p. .

[Mao Qianjin et al. ()] 'Selfhealing effect of calcium alginate/epoxy microcapsules in cement-based materials'. Mao Qianjin , Wu Wenwen , Liang Peng . *Materials Reports* 2018. 32 (22) p. .

[Mao Qianjin et al. ()] 'Selfhealing effect of calcium alginate/epoxy microcapsules in cement-based materials'. Mao Qianjin , Wu Wenwen , Liang Peng . *Materials Reports* 2018. 32 (22) p. .

[Lv et al. ()] 'Synthesis and characterization of a new polymeric microcapsule and feasibility investigation in self-healing cementitious materials'. L Lv , Z Yang , G Chen . *Construction & Building Materials* 2016. Feb.15. p. .

[Wang et al. ()] 'The effect of synthesis condition on physical properties of epoxy-containing microcapsules[J]'. R Wang , H Hu , W Liu . *Journal of Applied Polymer Science* 2012. 124 (3) p. .

[Dry and Mcmillan ()] 'Three-part methylmethacrylate adhesive system as an internal delivery system for smart responsive concrete'. C Dry , W Mcmillan . *Smart Materials & Structures*, 1999. 5 p. 297.