ISSN 2663-1563 Vol. 4, Issue 2: 12-15, DOI: 10.25236/AJAGE.2022.040203

Review on Effect of Admixtures on Basic Magnesium Sulfate Cement

Qiutong Jiang[1,2], Changming Bu[1,2,*], Yi Sun[1,2]

[1]School of Civil Engineering and Architecture, Chongqing University of Science & Technology, Chongqing 401331, China
[2]Chongqing Key Laboratory of Energy Engineering Mechanics & Disaster Prevention and Mitigation, Chongqing 401331, China
**Corresponding author: buchangming@cqust.edu.cn*

Abstract: *Basic magnesium sulfate cement is a kind of green gel material with emphasis on admixtures. As a new green sustainable building material, it has been widely used in the world. The additives of basic magnesium sulfate cement are divided into chemical admixtures and mineral admixtures. In this paper, the effects of chemical admixtures (citric acid) and mineral admixtures (rice husk Ash) on basic magnesium sulfate are studied respectively. the aim is to provide a theoretical reference for the further study of basic magnesium sulfate cement.*

Keywords: *Basic Magnesium Sulfate Cement, Rice Husk Ash, Chemical Admixtures*

1. Introduction

Portland Cement as a major basic material in the field of contemporary civil architecture has many advantages, such as high strength, high hydration heat, good frost resistance and so on. However, its poor corrosion and heat resistance limits its use to a certain extent, and due to the production of Portland Cement will release a large amount of carbon dioxide (0.7-1.0 t of carbon dioxide per ton of Portland Cement), excessive consumption of non-renewable mineral resources has led to serious environmental, energy and resource problems. Therefore, the development of sustainable green building materials has become an urgent need for sustainable development [1].

Basic magnesium sulfate cement is a new type of MgO-MgSO4-H2O cement material, which is based on magnesium oxide and magnesium sulfate heptahydrate as main raw materials. Basic Magnesium Sulfate Cement (BMSC) and magnesium oxychloride cement (MOC), magnesium oxychloride cement (MOS) and magnesium phosphate cement (MPC) belong to the category of magnesium cementitious materials, but basic magnesium sulfate cement different from other magnesia cementitious materials overcomes the disadvantages of poor water resistance of magnesium oxychloride cement and low strength of magnesium oxychloride cement. it has the advantages of quick setting, early strength, waterproof, heat insulation, and corrosion resistance as well as excellent mechanical properties [2].

Although there are a lot of research reports on magnesia-based cementitious materials, there are few studies on basic magnesium sulfate cement on adding green additives, the future research of basic magnesium sulfate cement should focus on adding additives and green admixtures to develop a new type of environmental protection building cement. BMSC differs from other magnesium cements in that it is a cementitious material that highlights admixtures. Both chemical admixtures and mineral admixtures aim at improving the properties of basic magnesium sulfate cement.

2. Chemical admixtures

Magnesium cement generally has the character of early strength, the hydration heat peak appears early, and the addition of additives such as sodium citrate in magnesium sulfate solution can inhibit the hydrolysis of magnesium ions in the solution to bypass reaction[3].The PH value of the slurry can be adjusted to a certain extent [4]. Chemical admixtures such as citric acid, malate, sodium gluconate, tartaric acid and calcium sulfate, etc. [5]. Tartaric acid (TA) and citric acid (CA) have the strongest adsorption ability on the surface of Mgo, and citric acid is more effective than tartaric acid in inhibiting the hydration and stabilizing the apparent volume[6].Citric acid can not only play the role of retarding

ISSN 2663-1563 Vol. 4, Issue 2: 12-15, DOI: 10.25236/AJAGE.2022.040203

coagulation, but also form a multi-tooth ligand with magnesium ion according to some studies. It also can adsorb on the surface of Mgo and react with its surface layer. The formation of a stable hydrated hydroxyl magnesium ion intermediate, a trinuclear complex, is strongly adsorbed on its surface to promote the development of a more fine needle-like 5•1•7 phase. In the aspect of strength, different admixtures (Shown in Table 1) and the different amount of each admixtures (Shown in Table 2) have different effects on the strength. Zeng, et [2] It was found that the strength increased obviously when citric acid was added above 0.1% , but the strength decreased when citric acid was added to 0.33% of the active magnesium oxide can be seen in the table as well. There was also a significant reduction in magnesium hydroxide and magnesium carbonate [7].

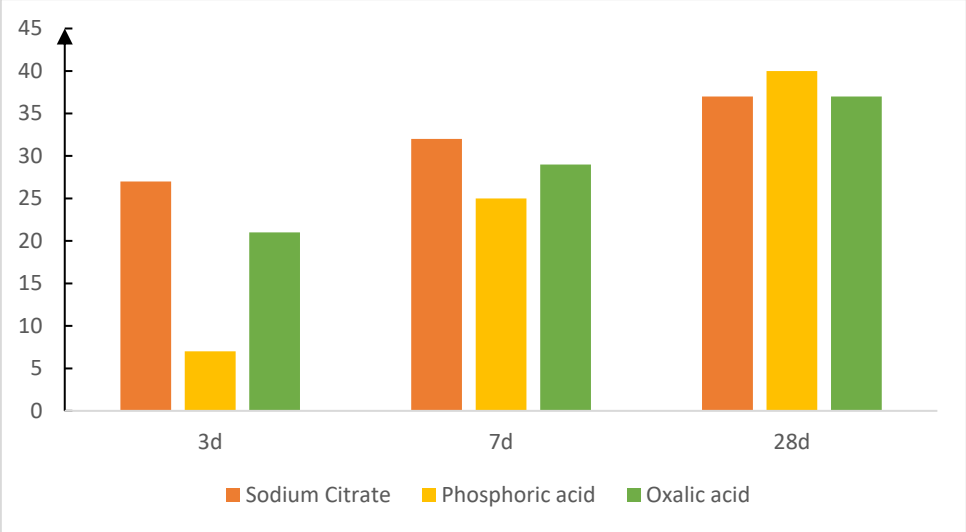

Table 1: Different admixtures of BMSC [2, 8]

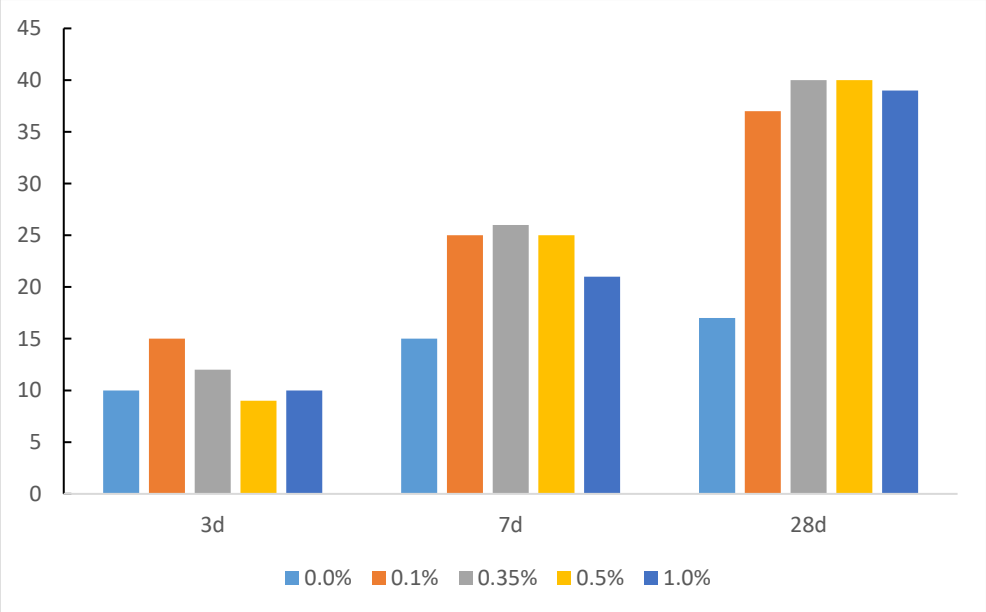

Table 2: Different amount of each admixtures of BMSC [2]

3. Mineral admixtures

In addition to various chemical admixtures there are various kinds of mineral admixtures in many studies, common rice hull ash, fly ash, silica fume and so on. Rice is one of the three most important food crops in the world, along with corn and wheat. Between 2019 and 2020, the world produced 496 million tons of rice, according to a new report from the Food and Agriculture Organization of the United Nations. Rice Husk (RH) is the husk of rice grain, 20% of the total yield of rice is rice husk. Rice accounted for 72%, bran for 5-8% and bran for 20-22%, the results showed that the content of amorphous silicon

ISSN 2663-1563 Vol. 4, Issue 2: 12-15, DOI: 10.25236/AJAGE.2022.040203

dioxide in rice husk was abnormally high [9, 10]. The amorphous silicon dioxide is essentially silicon dioxide, which is one of the most active silicon dioxide [11, 12]. It is concluded that rice husk ash can be used as green concrete composite materials and be applied to the industrialization of ecological buildings [10]. At present, it is found that rice husk ash is added to geopolymer based on fly Ash [13], ultra high performance concrete [14], magnesium phosphate cement and other materials. The addition of rice husk ash can alleviate sulfate attack on the surface of the material, and the samples with rice husk ash also exhibit superior strength degradation compared to the Portland Cement. Although there are many researches on rice husk ash as admixture, there are few researches on basic magnesium sulfate cement with rice husk ash at present. At the moment, most research will be on the rice husk pretreatment, such as reasonable calcination and grinding, can greatly increase its non-qualitative silicon dioxide content to improve its activity, which will play an important role in improving the performance [15]. However, unreasonable burning of rice husk ash will not only make it not a green building material, but also cause environmental pollution. Currently, most rice husks are handled in a controllable way such as fluidized bed and industrial furnace. In addition to burning and grinding methods, existing research also uses hydrochloric acid, sulfuric acid and acetic acid to pretreat rice husks, and said that the pretreated Rice husks appear yellow-white and are more easily burned fully in combustion, it was found that the performance of rice husk soaked in hydrochloric acid was the best after controlling the concentration and soaking time [16]. In addition to rice husk ash, slag , silica fume [17], borax [18], fly Ash [2, 19, 20] etc, has been used in many researches [21]. In order to study the influence of these additives on the physical and mechanical properties of cement, the internal substitution method is mostly used.

4. Conclusion

The following conclusions can be drawn from the analysis of chemical admixtures and mineral admixtures in the existing literature:

(1) In delaying water reactions, improved cement strength, sodium citrate is more remarkable than other extra additional effects, and 0.5% WT in MgO is generally achieved by the growth of 5•1•7.

(2) As a mineral admixture, Rice Husk ash can effectively alleviate sulfate attack on the surface of materials, improve the compactness of cement, and the samples added Rice Husk ash also show excellent strength deterioration.

To sum up, although there are many researches on chemical admixtures, there is still much room for further research on the effects of various mineral admixtures on Basic Magnesium Sulfate Cement.

Acknowledgements

This paper is based upon work supported by technology innovation project in Chongqing University of science and technology (No. YKJCX2020628).

References

[1] Ytab C, Hy C, Ss D, et al. Properties and microstructure of basic magnesium sulfate cement: Influence of silica fume [J]. Construction and Building Materials, 2020, 266: 1-2.
[2] Zeng X, Yu H, Wu C. An Overview of Study on Basic Magnesium Sulfate Cement and Concrete in China (2012–2019)[J]. KSCE Journal of Civil Engineering, 2019, 23(10): 44-53.
[3] Zhang N, Yu H, Ma H, et al. Effects of different pH chemical additives on the hydration and hardening rules of basic magnesium sulfate cement [J]. Construction and Building Materials, 2021, 305:4-6.
[4] Na Z, Yu H, Ma H, et al. Effect of Ammonium Citrate Tribasic on the Hydration Reaction and Properties of Magnesium Oxysulfate Cement [J]. Journal of Materials in Civil Engineering, 2021, 33 (11): 1.
[5] Wang Aiguo,Chu Yingjie,Xu Haiyan,Liu Kaiwei,Ma Rui,Dong Weiwei,Sun Daosheng. Research Progress and Performance Improvement Technology of Basic Magnesium Sulfate Cement [J]. MATERIALS REPORTS, 2020, 34(13): 95-103.
[6] Amaral L F, Oliveira I R, Bonadia P, et al. Chelants to inhibit magnesia (MgO) hydration [J]. Ceramics International, 2011, 37(5): 15-42.
[7] Miao M, Wu C, Xing S, et al. Effect of Different Additives Addition on Basic Magnesium Sulfate Cement Composite Sheet [J]. IOP Conference Series: Earth and Environmental Science, 2019, 358.
[8] Chen L, Jiang L, Chu H, et al. Effect of retarder on hydration properties of light-burned magnesia

ISSN 2663-1563 Vol. 4, Issue 2: 12-15, DOI: 10.25236/AJAGE.2022.040203

[J]. Construction and Building Materials, 2020, 263.
[9] HOUSTON, FAIRCHILD D. Rice: chemistry and technology [M]. Rice: chemistry and technology/.
[10] Amran M, Fediuk R, Mu G, et al. Rice Husk Ash-Based Concrete Composites: A Critical Review of Their Properties and Applications [J]. Crystals, 2021, 11(2).
[11] Kamiya K, Ai O, Nasu H, et al. Comparative Study of Structure of Silica Gels from Different Sources [J]. Journal of Sol-Gel Science and Technology, 2000, 19(1-3).
[12] Chaudhary D S, Jollands M C. Characterization of rice hull ash [J]. Journal of Applied Polymer Science, 2004, 93(1): 1-8.
[13] Zhu H, Liang G, Xu J, et al. Influence of rice husk ash on the waterproof properties of ultrafine fly ash based geopolymer [J]. Construction and Building Materials, 2019, 208(MAY 30): 394-401.
[14] Asf A, Sam B, Bat C, et al. The effect of using nano rice husk ash of different burning degrees on ultra-high-performance concrete properties [J]. Construction and Building Materials, 2021, 290.
[15] Liu R, Bo P, Xz C, et al. Effect of rice husk ash on early hydration behavior of magnesium phosphate cement-ScienceDirect [J]. Construction and Building Materials, 2020, 263.
[16] Chen Pei. EFFECT OF PRETREATMENT ON PROPERTIES OF RICE HUSK ASH [D]. Harbin Institute of Technology, 2014.
[17] Chen Congxing, Wu Chengyou, Luo Kejia, et al. Experimental study on the effect of fly ash and silica fume on dolomite-based basic magnesium sulfate cement [J]. New Building Materials, 2020, v.47; No.469(01): 59-62.
[18] Li Y, Shi T, Chen B. Experimental Study of Dipotassium Hydrogen Phosphate Influencing Properties of Magnesium Phosphate Cement [J]. Journal of Materials in Civil Engineering, 2016, 28(4).
[19] Mo L, Lv L, Deng M, et al. Influence of fly ash and metakaolin on the microstructure and compressive strength of magnesium potassium phosphate cement paste [J]. Cement and Concrete Research, 2018, 111 (116-29).
[20] Chengyou Wu. Fundamental theory and civil engineering application of basic magnesium sulfate cement [D]. The University of Chinese Academy of Sciences, 2014.
[21] He Liang. Research on Mix Proportion Design of Basic Magnesium Sulfate Cement Concrete[D]. Nanjing University of Aeronautics and Astronautics, 2016.