

Nano MMT modified PMMA anti-skid coating material design and pavement construction technique

Yongqiang Zhong ^{1*}

¹Transportation College, Huaiyin Institute of Technology, Huai'an 223003, China

Email: zyqjlu@126.com

Abstract. For the development of the mechanical properties of better color anti-skid road surface coating material, nano MMT modified Polymethylmethacrylate was designed. Then tensile strength tests before and after coating materials nano modified were done by universal testing machine and preparation specimens. The results show that PMMA strength with adding MMT is significantly higher than no additive under different hardening agent ratio. The construction process of the nano-modified two-component color anti-skid pavement on the cement road surface then is introduced by the construction of test road of colorful anti-skid pavement structure.

1. Introduction

Color anti-skid road surface is laid in the original road surface (Fig.1). Color anti-skid road surface is consist of the base course, road surface (asphalt or cement concrete pavement), adhesive layer, color non-slip aggregate protection layer.

Pavement + adhesive coating+ color aggregate is now the most commonly used anti-skid road structure[1]. The laying sequence makes perfect combination of the glue with pavement and color non-slip aggregate. Because colored pavement layer is thinner, the influence of vehicle into the road surface is small[2, 3]. It makes driving more smooth. Coloured aggregate is shown in Fig.2. This paper studies its non-slip coating material.

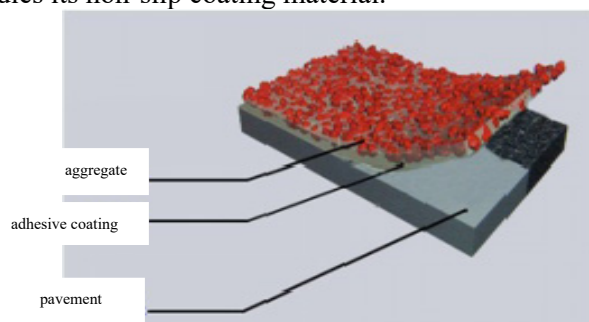


Fig.1 Color anti-skid road surface structure

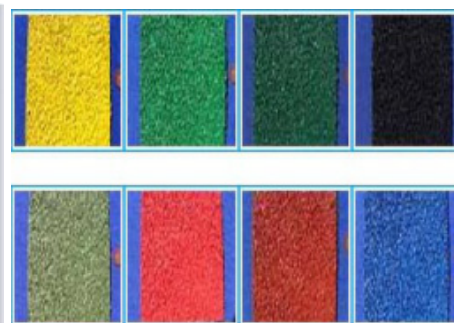
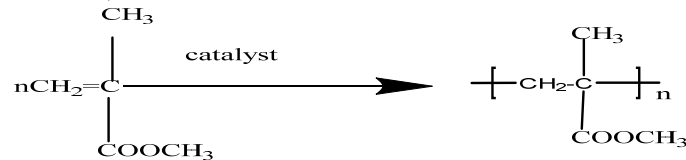


Fig.2 Color aggregate diagram

2. Material and Methods

Polymethylmethacrylate can be abbreviated to PMMA. It is so far the most excellent material quality of synthesis transparent material and the price is cheaper. PMMA resin is a virulent environmental protection material and a colorless liquid, as shown in Fig.3. Its boiling point is 101 °C and the

density is 0.940 g/cm^3 [4,5]. It is the base material of adhesives for color anti-skid road and it has good chemical stability and weather resistance. The shortcoming of PMMA resin is very brittle cracking, surface strength is low [6, 7]. Its chemical reaction equation is indicated below. Nano MMT is a natural mineral silicate. MMT chemical structural formula can be written as: $\text{Na}_{0.7}\text{Al}_{33}\text{Mg}_{0.7}\text{Si}_8\text{O}_{20}(\text{OH})_4 \cdot n\text{H}_2\text{O}$. MMT contains 50% to 70% SiO_2 , 15% to 20% Al_2O_3 .



Polymethylmethacrylate binder is a two-component polymer material. In construction with the other components (named hardening agent $\text{K}_2\text{S}_2\text{O}_8$), it will form the final mesh structure of high polymer by making the material produce rapid secondary crosslinking reaction [8-10]. In order to develop better adhesive performance, nano MMT will be added to polymethylmethacrylate adhesives. By contrast test research of adding different proportion MMT nanoparticles and considering mechanics and economic performance, the test choice adding 3% of nano MMT together with 1%, 2%, 3%, 4%, 5% five different hardening agent of polymethylmethacrylate to do adhesive performance testing. Specific material composition design is shown in Tab.1.

Tab.1 Two-component nano modified polymethylmethacrylate materials design

Group number	MMA (g)	Hardening agent	MMT(g)
1	100	1	3
2	100	2	3
3	100	3	3
4	100	4	3
5	100	5	3

By Tab.2, polymethylmethacrylate adhesive bond strength is between 30 MPa and 35 MPa. As a whole the bonding degree decreases with the increase of hardening agent. By adding 3% of MMT, polymethylmethacrylate adhesive strength is between 35 MPa and 40 MPa. No matter how much content of hardening agent, the bond strength by adding 3% nano MMT is bigger than the bond strength without adding nano MMT materials. The bond strength reduces the colored anti-skid pavement threshing phenomenon and greatly improves the colored anti-skid pavement durability. When adding 1%, 2%, 3%, 4%, and 5% curing agent, the curing time is within 1h. With the increase content of curing agent, curing time is reduced. Color pigments and various additives were added to make anti-skid road coating materials.

Tab. 2 PMMA adhesive strength before and after adding 3% nano MMT

Content of hardening agent (%)	1	2	3	4	5
Bond strength without nano MMT (MPa)	34.71	34.59	34.07	33.58	32.92
Bond strength by adding 3% nano MMT (MPa)	39.28	38.44	37.16	36.64	38.83

3. Colorful anti-skid coating construction technique

The construction process of the nano-modified two-component color anti-skid pavement on the cement road surface is shown in Figure 3 below by the construction of test road of colorful anti-skid pavement structure. There are mainly six steps in construction.

- 1) The cement pavement base has been polished;
- 2) Cement surface is roughening treated;

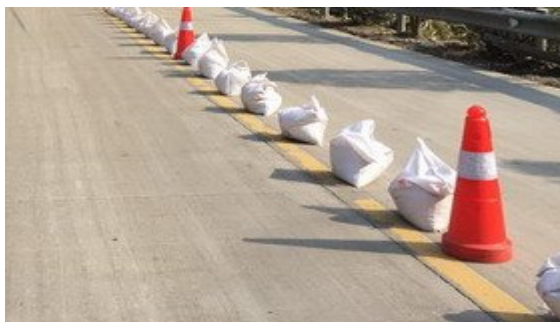
- 3) Construction preparation is done;
- 4) Seal primer is coated and evenly permeated (not less than 1.5kg/m²);
- 5) Colored aggregate is constructed on the surface;
- 6) The surface aggregate is cleaned after curing and drying.



1) Polishing treatment of cement pavement base



2) Cement surface roughening treatment



3) Construction preparation



4) Seal primer coating and uniform penetration



5) Construction of colored aggregate on surface



6) Clean surface aggregate after curing and drying

Fig. 3 Process diagram of color anti-slippery road surface construction

4. Conclusions

Polymethylmethacrylate adhesives with nano MMT can significantly increase the bonding strength. By adding 3% of nano MMT to polymethylmethacrylate, adhesive strength is between 35 MPa and 40 MPa. Hardening agent can reduce the curing time. The construction process of the nano-modified two-component color anti-skid pavement on the cement road surface is introduced by the construction of test road of colorful anti-skid pavement structure.

Acknowledgement

In this paper, the research was sponsored by the Project supported by Jiangsu Provincial Transportation Science and technology and achievements transformation project (Project No.

Z413B17322), Six talent peaks project in Jiangsu Province and the Natural Science Foundation of the Jiangsu Higher Education Institutions of China(Grant No. 15KJB580002).

References

- [1] Zhao An-ping, Thang Aiping. Color non-slip surface coating properties and applications [J]. Road construction machinery and construction mechanization, 2013, (02) : 31-34.
- [2] Lv Wei-min ,Li li-han. Both at home and abroad the research and application of colored pavement [J]. Journal of Shanghai municipal engineering, 1998, (02) : 53-55.
- [3] Bellotti C,Bellotti F,Gloria AD.Developing a near infrared based night vision system[C].IEEE Intelligent Vehicles Symposium,2004:14-17.
- [4] GongChangsheng Zhang Kesheng. New functional materials [M]. Beijing: chemical industry press, 2001.
- [5] Zhang Shenglin,Zhao an-ping , Shang Aiping, Yu xue-mei .current situation and the development of colored antiskid pavement [J]. Journal of . road construction machinery and construction mechanization, 2013, (02) : 26 -30.
- [6] Wang Liangyan, Han Daojun, Chen Shizhou. Color pavement technology and development [J]. Journal of transportation science and technology and economic, 2009,52 (02) : 21-30.
- [7]Chen Shiwei,Lu Xuchen, Zhang Zhimin.Preparation and characterization of poly(methyl methacrylate)reactive montmorillonite nanocomposites[J].Polymer composites,2016,2396-2403
- [8] Ma Zhong-nan .Research quality skid coatings and application technology [J] .Highway and Transportation Research: Application and Technology, 2012 ,(2): 89-92
- [9] Luo Hai-bing. Colored pavement technical solutions and color non-slip surface design [J]. China Municipal Engineering, 2007, (2): 11-16.
- [10] Shao Qi, Li Aiguo, Ran Meng- Jiang. International Airport Highway colored pavement design and application [J] .Highway, 2009, (6): 193-196.