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

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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.

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 avirulent 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/cm³ [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 indicated below. Nano MMT is a natural mineral silicate. MMT chemical structural formula can be written as: Na0.7Al33Mg0.7Si8O20(OH)4·nH2O. MMT contains 50% to 70% SiO2, 15% to 20% Al2O3.

Polymethylmethacrylate binder is a two-component polymer materials. In construction with the other components (named hardening agent K2S2O8), it will form the final mesh structure of high polymer by making the material produces 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.

| 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 thershing 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.

| 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.

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.

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