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An Innovative Salt-storage Aggregate Made in Our Laboratory

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Introduction

- When snow freezes on the road surface, the friction coefficient between the asphalt concrete pavement and the passing wheels is greatly reduced.
- Methods of passive deicing are low efficiency and poor removal effect.
- In recent years, the technology of salt storage and self-melting snow pavement mixed with salt compounds has become a research hotspot.
- Most of the domestic research for ice-melting is difficult to get the original formula of snow melt directly due to design secrecy and other reasons.
- There is no scientific and reasonable method to evaluate the de-icing and snow-melting performance of salt storage asphalt concrete pavement.

Mechanical snow and ice removal

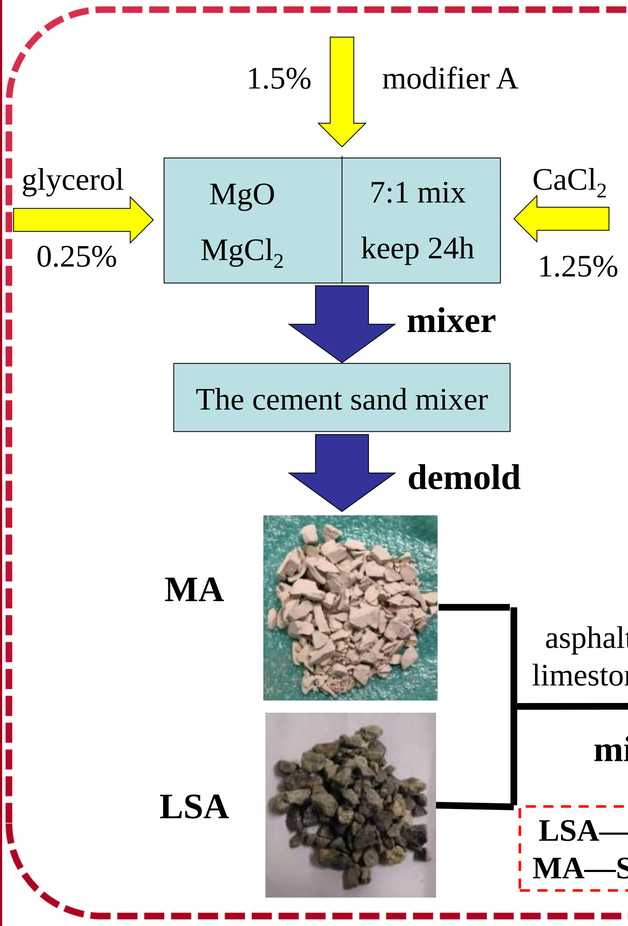
Damage to buildings by chlorine salt snowmelt

Geothermal conduit lines

Objectives

- A self-made MA with a particle size range of 0.075mm~4.75mm 0.075mm ~ 4.75mm, was added to asphalt mixtures to replace part of fine aggregates.
- Determined the optimal replacement rate for salt storage aggregates.
- The salt release performance and de-icing properties of the asphalt mixture were studied.

Material Preparation



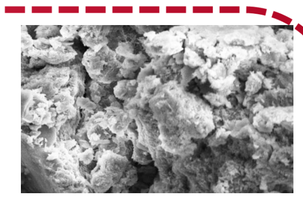


Fig. 1. SEM images at magnification factor of 1500.

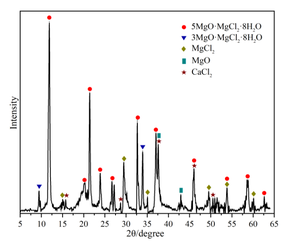
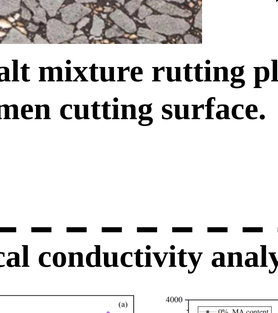


Fig. 2. X-ray diffraction pattern of MA.

Testing Methods and Results

High-temperature stability



Rutting test specimens

- A solid rubber wheel with 0.7 MPa pressure at a speed of 42 cycles per minute was used for one hour of rolling compaction with the temperature constant at 60 ℃.

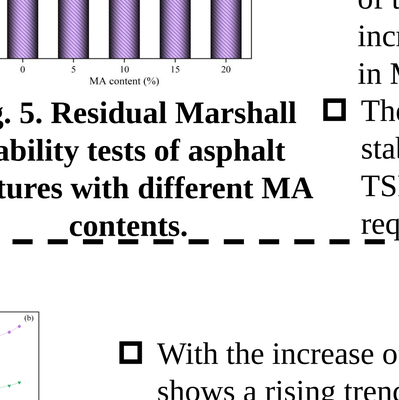


Fig. 3. Rutting tests of asphalt mixtures with different MA contents.

- The dynamic stability of asphalt mixture with snowmelt materials increases first and then decreases with the increase of dosage.
- When the volume content of MA is 15%, the high-temperature stability reaches the maximum. Therefore, the optimum content of MA is 15%.
- The MA content increases to a certain extent, MA will be broken due to insufficient strength.

Bending test at low temperature

Low temperature bending test equipment

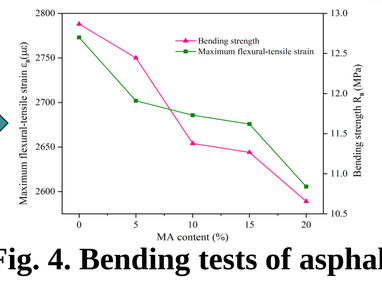


Fig. 4. Bending tests of asphalt mixtures with different MA contents.

- It can be seen from the figure that the bending strength R_B and max flexural-tensile strain ε_B of the mixture decrease with the increase of MA volume fraction.
- Since the MA outer layer absorbs the light components in asphalt, the asphalt between aggregates becomes viscous and the low-temperature performance becomes worse.

The bending test provides a measure of low-temperature stiffness and relaxation properties of asphalt binders.

Water stability performance

MA asphalt mixture rutting plate specimen cutting surface.

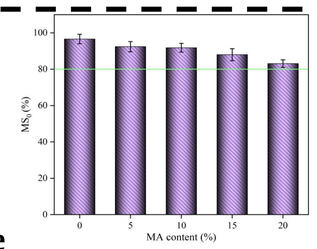


Fig. 5. Residual Marshall stability tests of asphalt mixtures with different MA contents.

- It can be seen that the MA aggregates are uniformly distributed inside the mixture.
- The results showed that the water stability of the asphalt mixture decreased with the increase of MA contents. Because the salt in MA has hygroscopicity.
- The paper also evaluates the water stability of asphalt mixtures by conducting TSR tests, which all meet the specification requirement.

Electrical conductivity analysis

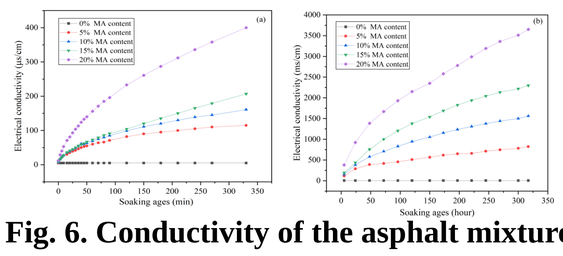


Fig. 6. Conductivity of the asphalt mixtures with MA: (a) soaking for 330 min; (b) soaking for 317 h.

- With the increase of test time, the electrical conductivity shows a rising trend firstly, and then shows a trend of slowing down. This is due to the release of salt in salt storage aggregates.

Snow-melting durability analysis

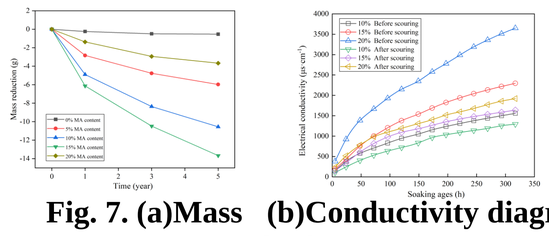


Fig. 7. (a)Mass change diagram of Marshall specimens. (b)Conductivity diagram of Marshall specimen after simulated rain scouring test.

- The quality of Marshall specimens under different replacement rates shows a downward trend with the growth over the years.
- The electrical conductivity curves of Marshall specimens with different replacement rates rise with the increase of time, but the growth rate of electrical conductivity falls down with the increase of time.
- The asphalt mixture with MA after five years of simulated rainfall scouring still has snow melting and ice suppression effect.

Conclusions

- The surface of salt-storage aggregate MA is loose and has many micropores, this structure facilitates the release of CaCl2. The glycerol component in MA can play a sustained-release effect.
- With the increase of MA content, the high-temperature performance of the mixture increases and then decreases, and the low-temperature and water stability performance decrease, but both can meet the specification requirements. Considering the influence of engineering performance, it is appropriate to add 15% MA.
- Marshall specimens with 15% and 20% replacement rates have good snow-melting and slow-release effects. Considering the influence of economic factors, the optimal replacement rate of MA is 15%.
- The conductivity of the Marshall specimen shows that the asphalt mixture still has the ability to remove ice and snow after 5 years.