Data Article

Dataset of wind blow sand erosion test on ultrasonic surface treated cementitious composites

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\textbf{ABSTRACT}

In this paper, we take cement mortar and paste as specimens, a novelty method named ultrasonic surface treatment (UST) was employed to form a hardening surface layer on cementitious specimens to improve its wind-blown sand erosion resistance, surface hardness and apparent density. The specimens with curing ages of 1-day, 3-days, 7-days, and 28-days were adopted. The wind blown sand erosion test was carried out in a wind-blown sand erosion test system, which simulated a wind blown sand environment of a wind speed of 30 m/s and a sand feed rate of 30 g/min. The erosion angle of 30°, 60°, 90° were adopted. The mass loss in erosion process was measured, then the erosion resistance was calculated. The surface hardness was tested with a Vickers micro hardness tester. The apparent density of cement paste was measured with mass volume method. The data provided reveal the improvement on wind blown sand erosion resistance, surface hardnness and apparent density of cementitious materials with ultrasonic surface treatment. That may be used in the investigation on improving the erosion resistance and to evaluate the effectiveness of the UST method on cementitious materials.

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Specifications Table

| Subject | Mechanics of Materials |
|---------|------------------------|
| Specific subject area | Erosion resistance of ultrasonic surface treated cementitious composites |
| Type of data | Tables |
| How data were acquired | The erosion resistance $R_E$ Wind blown sand erosion tests were tested in a wind-blown sand erosion test system, as shown in Fig. 1. The erosion resistance $R_E$(in cm$^3$/cm$^2$) that defined as the ratio between volumetric solid particle consumption and removed target material volume, was calculated in accordance with Eq. (1). The surface hardness was tested with a Vickers micro hardness tester, the surface of the UST and the contrast mortar specimens were polished properly before test. The apparent density was measured with mass volume method. |

Data format | Analyzed |

Parameters for data collection | With a wind-blown sand erosion test system, the wind speed was 30 m/s and sand feed rate was 30 g/min; the diameter of the nozzle was 10 mm, the space between the specimens and the nozzle was 100 mm. Erosion angles were 30°, 60°, and 90°. The specimens with curing ages of 1-day, 3-days, 7-days, and 28-days were adopted. The surface hardness was tested with force of 0.1 kgf and a loading time of 10 s for each test point. |

Description of data collection | The total erosion duration was 30 min, and within 10 min the mass loss was measured each minute. Then, the mass loss was measured every 5 min. 9 specimens in a group for each curing age and 3 specimens in a group for each test angle. The contrast specimens had the same quantity. Then the erosion resistance $R_E$ was calculated in accordance to Eq. (1). The surface hardness test, 33 data points were collected on each specimens and a 2 mm space between each sampling point was adopted. 3 specimens in a group. The apparent density of cement paste specimens was measured with growth of curing age, dried before testing, 3 specimens in a group. |

Data source location | Inner Mongolia University of Technology |
|-------------------------|------------------------------------------|
|                       | Hohhot, Inner Mongolia, China |
|                       | North latitude 40.846° and east longitude 111.677°: |

Data accessibility | With the article |
|-------------------|-----------------|
| Related research article | Shi Y, Shi ZM. Ultrasonic surface treatment for improving wind-blow sand erosion resistance of cementitious materials, WEAR |

Value of the Data

The data provided in this article revealed the improvement on wind blow sand erosion resistance, surface hardness and the apparent density of cementitious materials that treated with ultrasonic surface treat(UST) method.

These data can be used in the investigation on improving the erosion resistance and to evaluate the effectiveness of the UST method on cementitious materials.

1. Data description

Tables 1–4 is the erosion resistance $R_E$ of 1, 3, 7, and 28day age cement mortar specimens. Table 5 is the accumulate erosion resistance $R_E$ in a 30 min erosion.

In above table, $R_E$(in cm$^3$/cm$^2$) were calculated in accordance with Eq. (1).

$$R_E = \frac{\rho_M m_p}{\Delta m \rho_p}$$  \hspace{1cm} (1)

In Eq. (1), $\rho_M$ is the target material density, that is 2.204 g/cm$^3$; $m_p$ is the mass of grit consumption, that is 30 g/min; $\rho_p$ is the grit bulk density, that is 1.440 g/cm$^3$; $\Delta m$ is the target specimen mass loss. The total erosion duration was 30 min, and within 10 min the mass loss was measured each minute. Then, the mass loss was measured every five minutes.

Table 6 is the surface hardness of the specimens with curing age of 1, 3, 7, 14 and 28 days.
Table 1
Erosion resistance of 1day age specimens(cm³/cm³).

| Erosion time(minutes) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 15  | 20  | 25  | 30  |
|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 30°                   | CS  | 621 | 706 | 1312| 1640| 2187| 2417| 2701| 2870| 3532| 3280 | 3764| 4415| 4685|
|                       | UV  |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 60°                   | CS  | 429 | 883 | 1391| 1996| 2296| 1837| 2296| 2701| 2551| 2733 | 3532| 3891| 3891|
|                       | UV  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 90°                   | CS  | 516 | 778 | 1312| 1583| 2417| 2187| 2551| 2701| 2551| 2733 | 3532| 4592| 4865|
|                       | UV  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

Table 2
Erosion resistance of 3day age specimens(cm³/cm³).

| Erosion time(minutes) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 15  | 20  | 25  | 30  |
|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 30°                   | CS  | 1351| 3061| 3532| 3826| 4174| 2551| 3826| 5740| 5102| 3532 | 5600| 7174 | 7917|
|                       | UV  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 60°                   | CS  | 866 | 2087| 2820| 3532| 3532| 3826| 3826| 4174| 5339 | 5740 |     |     |     |     |
|                       | UV  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 90°                   | CS  | 850 | 464 | 1275| 1435| 1312| 1913| 1996| 1837| 2087 | 2367 | 2701| 2071 | 2251|
|                       | UV  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|                       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

Table 7 is the apparent density of the cement paste specimens that cured for 1, 3, 7, 14, 21 and 28 days.

In these tables, “UV” represents specimens which were treated with ultrasonic, “CS” represents the contrast specimens (Fig. 1).

2. Experimental design, materials, and methods

2.1. Experimental design

Wind blown sand erosion affecting the durability of cementitious composites in a windy sand environment [1,2]. Most researches focused on the erosion mechanism [3-5], a few studies focused on improving the erosion resistance [6,7]. In this paper, we take cement mortar and paste
Table 3
Erosion resistance of 7day age specimens(cm³/cm²).

| Erosion time (minutes) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 15  | 20  | 25  | 30  |
|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                        |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 30° CS                  | 1338| 2453| 2759| 2870| 2870| 3061| 2943| 2943| 3679| 4014| 6132| 6132| 7884| 8830|
| 30° UV                  | 1226| 2324| 3280| 3154| 3679| 3154| 3154| 3061| 6307| 4014| 6132| 7358| 8176| 8830|
| 30° CS                  | 849 | 1766| 2597| 3679| 3154| 3532| 3826| 3679| 4906| 6307| 6493| 7612| 8176| 11,038|
| 30° UV                  | 1208| 2087| 2870| 3826| 5102| 4592| 5102| 4592| 4592| 4592| 4592| 4592| 4592| 8503|
| 60° CS                  | 900 | 1913| 2187| 2296| 2187| 2551| 2417| 2087| 2417| 2187| 3327| 3532| 3958| 3958|
| 60° UV                  | 866 | 1640| 1701| 1913| 2087| 2187| 2187| 2187| 2296| 2296| 3102| 3479| 3703| 4028|
| 90° CS                  | 1093| 1913| 2087| 2296| 2187| 2417| 2187| 2187| 2296| 2296| 3102| 3479| 3703| 4028|
| 90° UV                  | 957 | 1640| 1837| 1913| 2087| 2187| 2187| 2187| 2296| 2296| 3102| 3479| 3703| 4028|

Table 4
Erosion resistance of 28day age specimens(cm³/cm²).

| Erosion time (minutes) | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 15  | 20  | 25  | 30  |
|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                        |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 30° CS                  | 1391| 1996| 2551| 2417| 2701| 4174| 4592| 5102| 4592| 5102| 6752| 8503| 10,436| 6752|
| 30° UV                  | 1208| 1640| 2087| 2701| 3061| 3280| 3532| 5740| 5102| 3826| 5600| 7917| 8503| 17,983|
| 30° CS                  | 1837| 3280| 3826| 5740| 7653| 5740| 6500| 6500| 9183| 8503| 8503| 11,479| 9982|
| 30° UV                  | 1435| 2701| 3280| 3826| 4174| 4174| 5740| 4592| 5339| 6774| 7174| 8199| 9183| 9982|
| 60° CS                  | 1068| 1701| 2296| 2296| 2417| 2417| 2417| 2551| 3061| 3061| 3061| 3061| 3061| 3061|
| 60° UV                  | 937 | 1701| 2296| 2296| 2417| 2417| 2417| 2551| 3061| 3061| 3061| 3061| 3061| 3061|
| 90° CS                  | 1351| 2087| 2870| 2417| 2296| 2296| 2296| 2296| 2551| 3061| 3061| 3061| 3061| 3061|
| 90° UV                  | 883 | 1391| 1766| 2087| 2087| 2087| 2087| 2087| 2551| 3764| 3764| 4028| 4592| 4991|

Table 5
Accumulate erosion resistance $R_t$(cm³/cm²) in 30 min.

| Curing time Species | 1d curing CS | 3d curing CS | 7d curing CS | 28d curing CS |
|---------------------|--------------|--------------|--------------|---------------|
|                     | 4332         | 5046         | 5464         | 6238         |
|                     | 3054         | 3848         | 4854         | 5083         |
| 1                   | 2717         | 4991         | 5238         | 4991         |
| 2                   | 2296         | 5140         | 4854         | 5083         |
| 3                   | 2482         | 4833         | 4696         | 4973         |
|                     | 2438         | 2834         | 3102         | 2888         |
|                     | 2152         | 2846         | 3109         | 2805         |
|                     | 2187         | 2624         | 2840         | 2852         |
|                     | 2187         | 2478         | 3124         | 3152         |
|                     | 2322         | 2834         | 3550         | 3311         |
|                     | 2285         | 3218         | 2969         | 3327         |
|                     | 2685         | 3327         | 4075         |              |

Erosion angle
as specimens, a novelty method named ultrasonic surface treatment (UST) was employed to form a hardening surface layer on specimens to improve its wind-blown sand erosion resistance and surface hardness, and to improve the apparent density of the cement paste.

Cement mortar specimens treated with and without UST method were prepared for wind blown sand erosion test and surface hardness test, 9 specimens in a group for each curing age and 3 specimens in a group for each erosion angle, and the contrast specimens had the same quantity. Cement paste specimens treated with and without UST method were prepared for apparent density measurement.

2.2. Materials

The specification of cement was PII52.2, the aggregate was ISO standard sand, The erosion particles was aelidi sand collected in Hobq Desert located at the Ordos Plateau, Inner Mongolia, China.
2.3. Methods

The composition and the mixing of the mortar specimens was in accordance with ISO 679:2009(E) [8]. The ultrasonic surface treatment was applied on mortar surface 30 min after pouring with a special mould, as shown in Fig. 2. The ultrasonic vibration power was 30 W with a duration of 30 min. The specimens were cut into blocks with a length of 50 mm and a thickness of 25 mm with curing age of 1, 3, 7, 28 days. The wind blown sand test was carried out in a wind-blown sand erosion test system, the wind speed was 30 m/s and the sand feed rate was 30 g/min, the erosion angle was 30, 60, 90°. The mass was weighed and the erosion resistance was calculated.
The surface hardness was tested with a Vickers micro hardness tester, the surface of the UST and the contrast specimens were polished properly. The data of the specimens with curing age of 1, 3, 7, 14 and 28 day were collected. 33 data points on each specimens and 2 mm space between each sampling point was adopted.

The apparent density was tested in accordance with mass-volume method. The cement paste specimens were cut into rectangles and the volume was measured, the mass was weighed with curing age of 1, 3, 7, 14, 21, 28 days, then the apparent density was calculated. The specimens were dried in 60 °C for 3 h before weighing.

**Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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**Supplementary materials**

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2020.105943.

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