Temperature Comparison Research of New Maintenance Method in Airport Pavement Concrete of China

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Abstract: Through comparing actual projects this paper presents and discusses the effects of curing film and geotextile on temperature of airport pavement concrete during maintaining process. The results show that, compared with the maintenance of geotextile, the curing film can ensure sufficient temperature, and it has very significant uniformity and continuity.

1. Introduction
The maintenance of concrete has always been the focus of attention. Until now, many effective research work has been carried out on the maintenance of concrete at home and abroad. A. Ramezanianpour[1] shows that, compared with control concrete, the strength of concrete containing fly ash or slag appears to be more sensitive to poor curing, and the sensitivity increases with the amounts of fly ash or slag in the mixtures increasing. J. M. Khatib[2] has discovered although conventional maturity formulas for Portland cement usually neglects the effect of humidity, this assumption is no longer valid especially under low relative humidity conditions. Nader Ghafoori[3] presented a study dealing with the influence of temperature on the fresh performance of self-consolidating concretes (SCC) made with slump flow of 508, 635 and 711 mm, and by way of admixture overdosing was successful to reverse the change in fresh properties of the self-consolidating concretes in elevated temperatures. Ahmed Loukili[4] found the autogenous relative humidity measurements show high self-desiccation within the CRC, and establishing a relationship between autogenous shrinkage and self-desiccation of CRC. A. Hajibabaeef[5,6,7] examines the impact of wet curing with different durations on differential drying shrinkage of concrete beams, provide important insight into the volume stability of slabs and the potential negative impact of wet curing on slab curling. Samir[8]studed the effect of curing period and of delay in carrying out curing by the wet burlap method on some properties of concrete, finding curing after delaying increased the compressive strength of concrete, but it did not recover the reduction in strength caused by the curing delay. Pietro Lura[9] found that higher temperatures do not lead to higher deformations within a certain age, but generally cause a faster shrinkage and a faster development of self-induced stresses. J.M. Ortega[10] is that cements with slag and fly ash hardened under environmental conditions of Atlantic and Mediterranean climates, can develop good service properties after three months of hardening. In order to better understand the relationship between hydration reactions and the evolution of mechanical properties of concrete, a. boumiz proposed a comprehensive method and verified it properly. Gonzalo Barluenga[11] assed the influence of mineral additions (MA) at early age and on hardened performance of fluid cement based pastes, finding the reaction degree of the samples during
the first 24 h was related to the microstructure development. Anne-Mieke Poppe[12] thought during concrete curing limestone and quartzite do influence the hydration processes due to a modified nucleus position and with a new hydration peak occurring. E.Holt[13] deeply studied the shrinkage behavior of concrete during curing, finding environmental factors greatly affect drying shrinkage, while material properties affect autogenous shrinkage. Research findings of C.Hua[14] capillary depression is the main origin of the autogenous shrinkage of hardening cement paste.

However, for the actual engineering site, the comparison of different conservation modes maintaining airport dry hard concrete and their internal structure analysis are rarely involved. This paper mainly based on the actual engineering environment compares the differences, advantages and disadvantages between the widely used geotextile maintenance method and the new curing film maintenance method, and provides engineering application and technical reference for the curing of dry-hard concrete in arid and water-deficient area.

2. Experiment
The test site was selected as the second phase expansion project of a new airport in Northwest China and the test time was summer. The planned construction scale of the project was about 350,000 m², and the test section area was 40,000 m². The main purpose of test is to make a reference and engineering basis for large-scale promotion of airport pavement dry-hard concrete maintenance in arid areas through the concrete maintenance comparison test at the actual construction site. The scene of two maintenance methods were shown in figure 1 and figure 2.

![Figure 1. Second phase expansion project of a new airport in Northwest China](image)

(a) Curing film maintenance  
(b) Geotextile maintenance

![Figure 2. Maintenance site](image)

(a) Curing film maintenance  
(b) Geotextile maintenance
3. Results and analysis

3.1. stage 1: 0-7d

During the period of 0-7 d, with concrete being cured by curing film and geotextile, the temperature changes in curing film and geotextile and the external environment temperature at corresponding time are shown in figure 3.

Three kinds of temperature changes are very similar and fluctuate with curing age. Daily they are generally shown as a process of first increasing and then decreasing. Within 0-7 days, the temperature in the curing film is distributed in 36-45°C, of which the data in the range of 39-44°C accounts for 82.9%; the temperature distribution in geotextile is in the range of 28-38°C, of which the data in the range of 30-35°C accounts for 82.9%; for the ambient temperature in this time range all the data is in the range of 25-37°C, and 71.4% of the total data is in the range of 28-33°C. The three groups of temperature values at each time during the 7-day curing period are: curing film temperature > geotextile temperature > ambient temperature. The temperature in curing film is significantly higher than that in geotextile and ambient temperature. The temperature in geotextile is also greater than that in ambient temperature, but the difference is relatively small.

![Figure 3. Geotextile, curing film and ambient temperature during age of 0-7 d (℃)](image)

![Figure 4. Temperature difference between film and ambience within 7d (℃)](image)

During the period of 0-7 d, with concrete being maintained by curing film, the difference between its temperature and ambient temperature at the corresponding time is illustrated in figure 4. As the age increases, the difference between the temperature inside the curing film and the ambient temperature generally shows a trend of decreasing. The law of variation is fitted, and the fitting equation is as follows:

\[ y = -0.07x^2 + 0.16x + 11.05, \quad R^2 = 0.62 \]  

(1)

The difference between curing film and ambient environment is all within the range of 8-13°C, wherein the values of 8-9°C, 9-10°C, 10-11°C, 11-12°C account for 11.4%, 28.5%, 31.4%, 22.8%, and 5.7%, respectively. For the values of 9-12°C, the total proportion is 82.7%.

During the period of 0-7 d, when the geotextile is used to maintain concrete, the difference between the ambient temperature and the temperature in geotextile is shown in figure 5. With the increase of curing age, the difference between the temperature inside geotextile and the ambient temperature decreases linearly. When the curing age reaches 7 days, there is no significant difference between the temperature inside geotextile and the ambient temperature. Linear fitting of the variation law is carried out, and the fitting equation is as follows:

\[ y = 0.58x + 4.48, \quad R^2 = 0.81 \]  

(2)

The temperature difference between the geotextile and the ambient environment is all in the range of 0-5°C. Among them, the values of 0-1°C, 1-2°C, 2-3°C, 3-4°C, 4-5°C account for 22.9%, 17.1%, 25.7%, 20.0% and 14.3%, that is, the values of 0-3°C account for about 2/3 of total values.
During the period from 0 to 7d, when the concrete is maintained by curing film and geotextile, the temperature difference between the two is shown in figure 6. During the whole age, the difference between curing film and geotextile does not show strong regularity, but it can be roughly divided into three sections: within 0 ~ 2d, the data values are all located in the 6-8°C interval; within 2~ 5d, the data values are mostly at 8-9°C, and some data are scattered in the range of 6-8°C; within 5 ~ 7d, the data values are almost all distributed in or near the 8-9°C interval. It shows that as the curing age increases, the temperature difference between curing film and geotextile is getting larger.

Figure 5. Temperature difference between geotextile and ambience within 7d (°C)

Figure 6. Temperature difference between curing film and geotextile within 7d (°C)

3.2. stage 2: 7-14d

During the period of 7-14d, when the curing film and geotextile are used to maintain concrete, the temperature in curing film, geotextile and ambient temperature are shown in figure 7. The curing film and geotextile all show very significant fluctuations with time, and the discreteness of respective data is further increased compared with 0-7d. One possible reasons is the increasing fluctuation of ambient temperature, because there is still a strong similarity between the trends of the three. Within 7 to 14 days, the curing film, geotextile and ambient temperature are in the range of 30-42°C, 25-33°C and 25-37°C, respectively. During the curing period of 7-9d, for the temperature values of three groups at each moment, the temperature of curing film is still much larger than the temperature of geotextile and the ambient temperature, and there is no significant difference between the geotextile temperature and ambient temperature. However, after the 9d curing age, the temperature of geotextile is gradually lower than the ambient temperature and the difference is getting larger.

Hence, in general, during the curing period of 7-14d, with concrete being maintained by curing film, the concrete is still at a higher curing temperature, which is conducive to the improvement of concrete performance.
The difference between the temperature inside curing film and the ambient temperature during 7-14d is shown in figure 8. As the age increases, the difference shows a tendency to gradually decrease and then slow down and finally accelerated decline. The variation law is fitted, and the fitting equation is as follows:

\[ y = -0.04x^3 + 1.42x^2 - 14.77x + 56.17, \quad R^2 = 0.57 \]  

(3)

The temperature of curing film is still 2°C higher than the ambient temperature on the 14d age, which means the curing film has excellent thermal insulation properties. Wherein, during the curing period of 7-9d, although with the increase of age the temperature difference trend decreases gradually, all these data are greater than 4°C; during the curing period of 9-12d, the difference remains basically unchanged and there is no notable temperature drop; during the curing period of 12-14 d, the difference begins to decrease significantly and the final value is still greater than 2°C.

During the period of 7-14 d, the difference between the temperature of geotextile and the ambient temperature is shown in figure 9. With the increase of age, these data shows a large discreteness and a linear downward trend. The fitting equation is as follows:

\[ y = -0.50x + 3.66, \quad R^2 = 0.40 \]  

(4)

When the curing age reaches 8 days, the geotextile temperature is gradually lower than the ambient temperature. With the increase of curing age, the difference between geotextile and ambient
temperature is larger. Throughout the whole curing period from 7 to 14 days, most data of the difference are distributed between 0 and -4°C, except for the initial part, most of the time, the temperature of geotextile is lower than the ambient temperature.

4. Conclusions
During the curing period of 0-7d and 7-14d, and the temperature of concrete surface is 8-13°C and 2-7°C respectively higher than the ambient temperature, which means the curing film has a very great thermal insulation effect throughout the process.

In the 0-7d, with geotextile being used for maintaining concrete, the difference value between concrete surface and ambient temperature decreases linearly. When reaching 7d age, there is no big difference between geotextile and ambient temperature. After the 9d age, all the concrete surface temperature are lower than the ambient temperature, and the Difference change ranges from 0°C to -6°C, indicating that the geotextile play a negative influence on heat insulation effect.

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