Experimental Investigation of Insulators' Icing Based on XMNIT

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1 Introduction

Background

- China is one of the countries which are frequently attacked by icing and icing accidents have reached up to thousands of times.
- Icing is a serious threat to the operation of power system.
- In early 2008, the freezing rain, rare in the history, attacked the south of China. This disaster brought great economic losses.

1 Introduction

- **Icing Environmental Conditions in Nature**
  - **Air temperature**
  - **Wind velocity and wind direction**
  - **Water droplet diameter**
  - **Liquid water content**

1 Introduction

Test Environments

Artificial climate chamber

- ✓ Easy to control environmental parameters
- ✓ Not limited by the season
- ✓ Strong repeatability

Natural environment

- ✓ Complicated and varied
- ✓ Weak repeatability
- ✓ Time-consumption

2 Tested Insulators

- **Tested Insulators**

Tab.1 Dim

Types	*D*
XP-300	320
XP-70	255
LXY-300	320
LXY-160	280

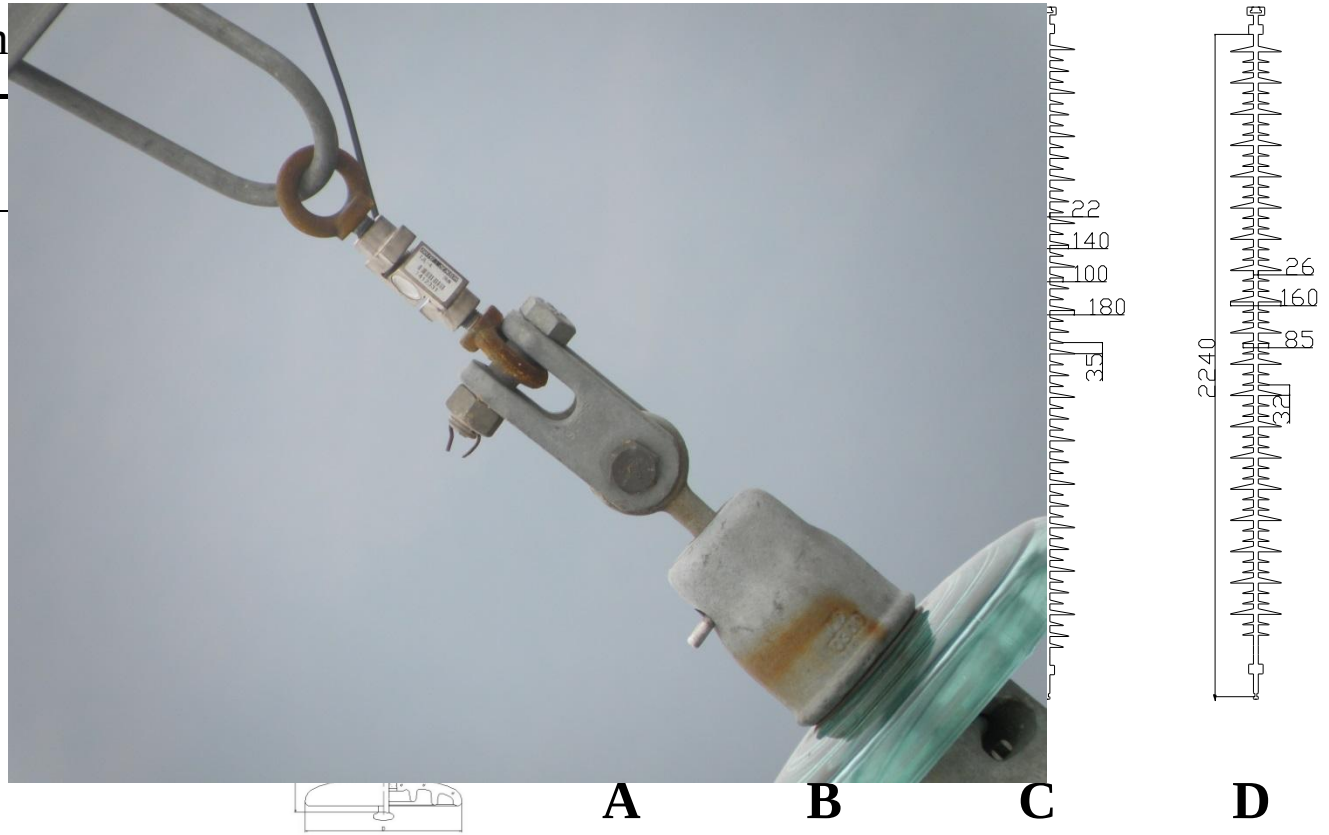


Fig.1 Profiles of composite insulators

3 Meteorological parameters

Temperature and relative humidity

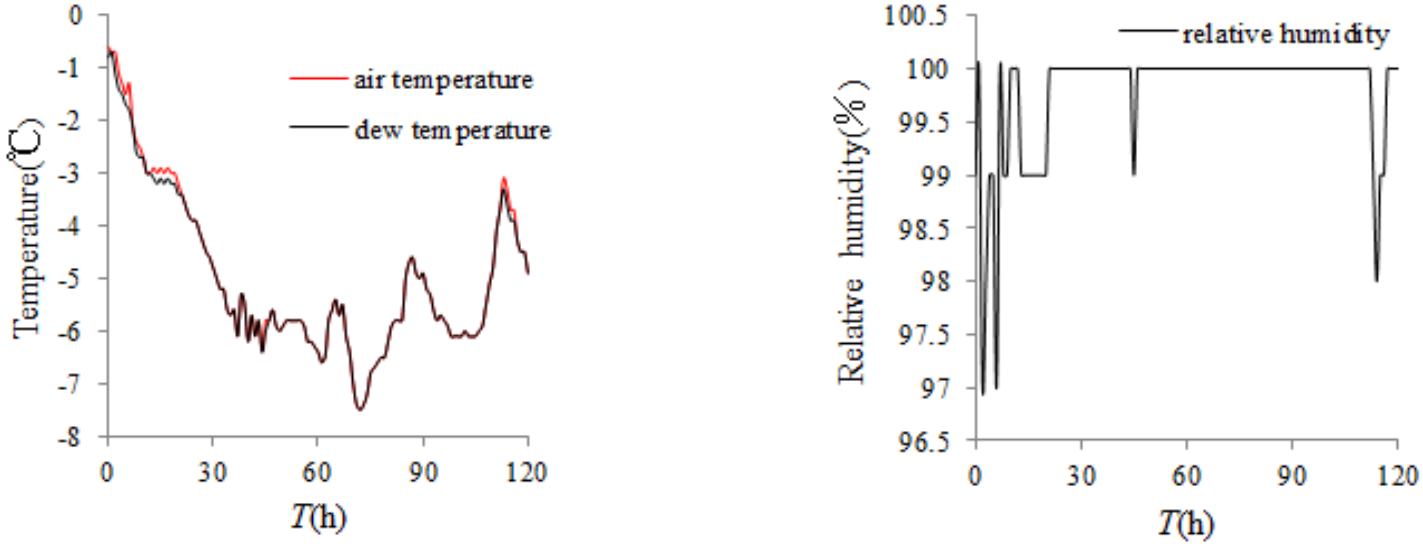


Fig.2 Ambient temperature and relative humidity

- ✓ **Air temperature was always below 0 ℃. Due to effect of wind, it declined linearly at early stage.**
- ✓ **Relative humidity remained at 100 % during the icing period, and it provided sufficient super-cooled water droplets for atmospheric structure icing.**

3 Meteorological parameters

- **Wind velocity and wind direction**

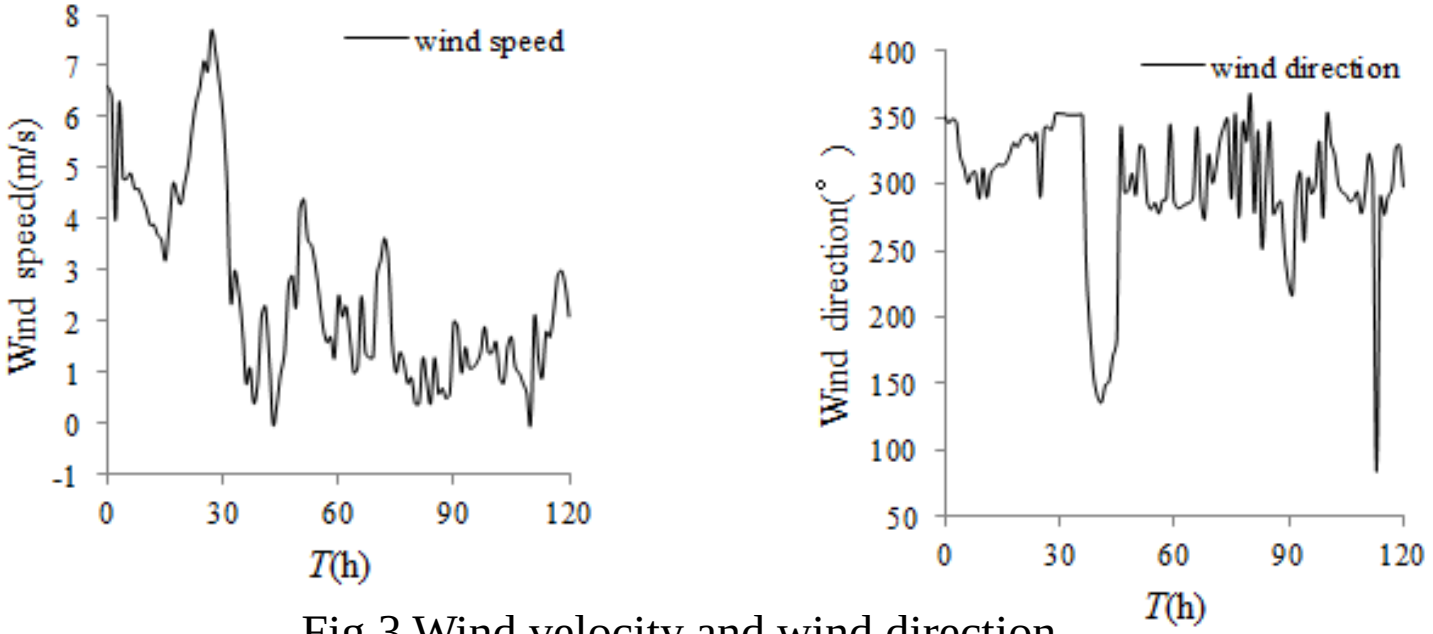


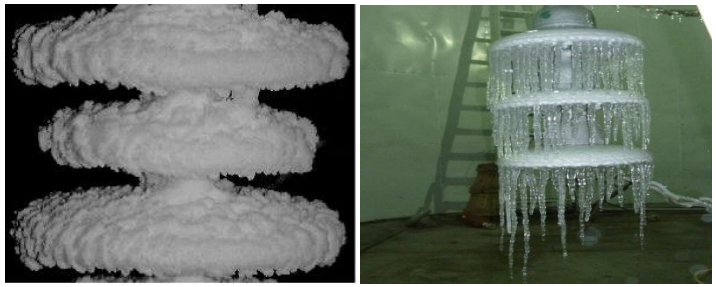
Fig.3 Wind velocity and wind direction

- ✓ **Wind velocity was high at the early stage and then fluctuated with alternative day and night.**
- ✓ **During most time of the ice period, wind blew from the northwest and north.**

4 Test Results and Analysis

Icing appearance

Test environments have a great influence on the icing appearance.



- ✓ **in the artificial climate chamber, two types of ice (glaze and rime) are uniform.**

- ✓ **However, in field test, it is totally different. Ice mainly exists on windward side of insulator and there is almost no ice on leeward side.**

Fig.4 Icing appearance

4 Test Results and Analysis

- **Ice mass of porcelain and glass insulator strings**

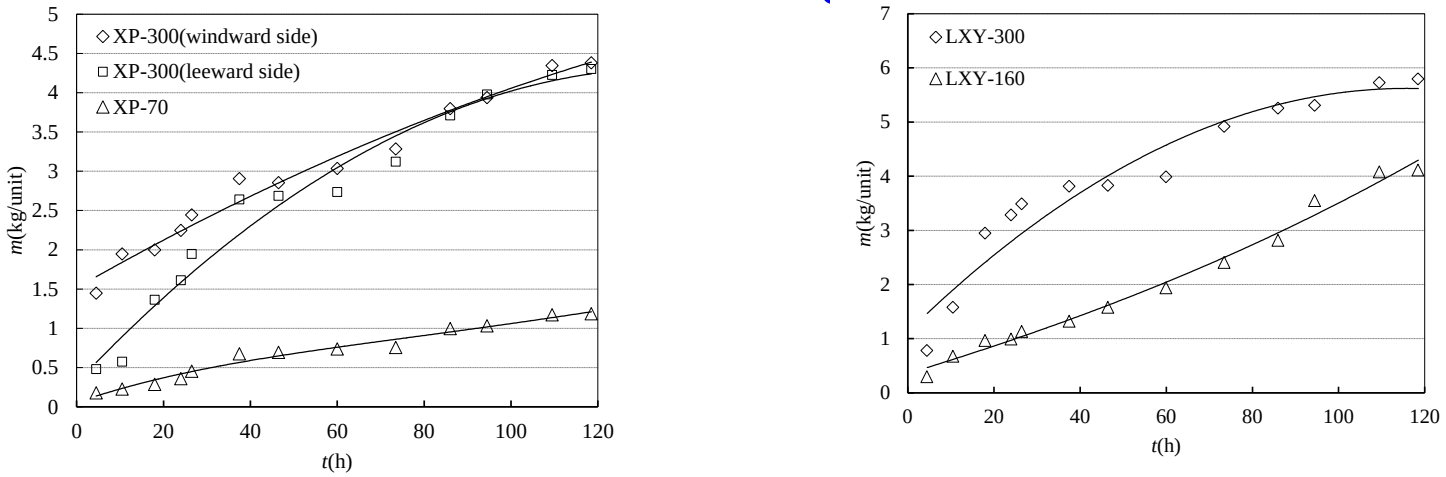


Fig.5 The growth of ice mass of insulator strings

- ✓ **The ice mass grows nonlinearly, while the growth degree is varied with the increase of time**
- ✓ **The larger diameter of the sheds of XP-300 and LXY-300 with the larger windward area could capture more super-cooled water droplets leading to more severe icing.**

4 Test Results and Analysis

- **Schematic diagram of experimental measurement**

Fig.6 The schematic diagram

This paper selects the extended length of icicle attached on the surface of insulator (l), ice thickness of the shed (d_0) and ice thickness of insulator's leeward side (d_1) as ice characteristics of ice-covered insulator.

4 Test Results and Analysis

- **Relationship between ice characteristics and ice accretion time for a single insulator**

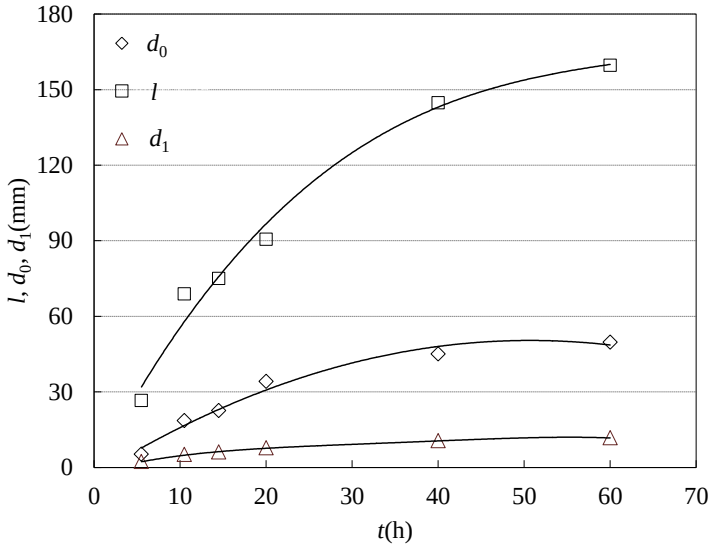


Fig.7 Relationship between ice characteristics and icing time

It is obvious that the ice growth rate of d_0 is significantly faster than that of d_1 and then both grow slowly. This can be explained by the fact that the shape of insulators is changed by ice, which results in collision coefficient reducing.

4 Test Results and Analysis

- **Relationship between ice characteristics and ice accretion time**

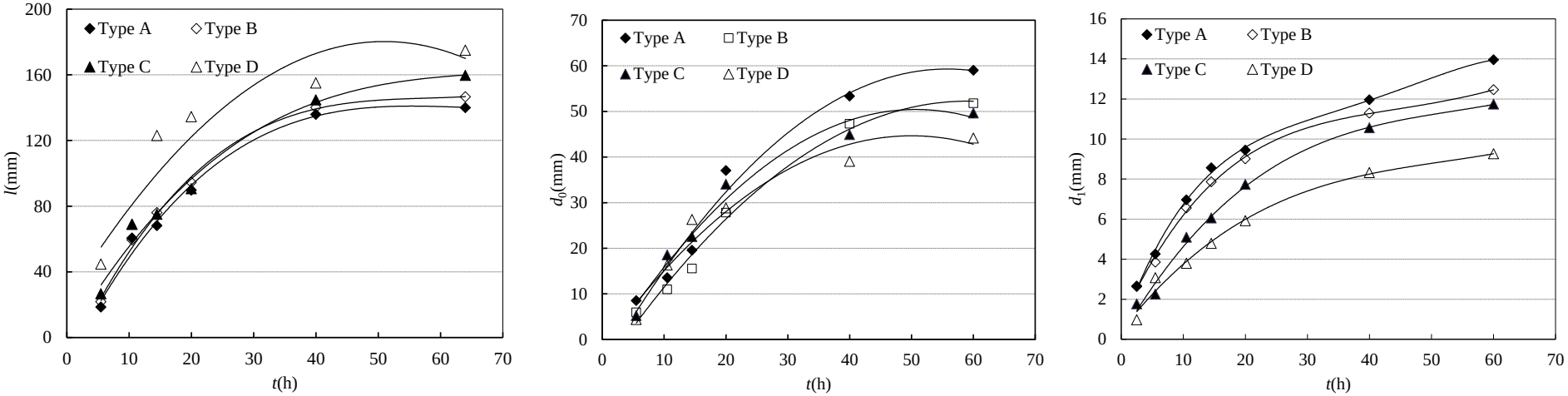


Fig.8 Relationship between ice characteristics and ice accretion time

Ice characteristics of ice-covered insulators grow nonlinearly with the increase of time. At early stage, the growth degree is fast and then drops.

4 Test Results and Analysis

Ice mass

Tab.2 Ice mass of four types of composite insulators

Types	A	B	C	D
Ice mass (kg)	16.15	16.54	17.32	17.09

The ice mass of Type C and D is heavier than that of another two types of insulators.

- The number of shed of Type C and D is larger.
- The diameter of shed of Type A and B is larger, which reduces ice accretion on insulators.

5 Conclusions

(1) There are considerable differences between the icing formed under artificial environment and that formed under natural environment.

(2) The icing formed under the field test is not uniform. And ice mainly exist on windward side of insulator and there is almost no ice on leeward side.

(3) With the increase of time, the ice mass grow nonlinearly, while the growth degree slows down.

5 Conclusions

(4) Icing of porcelain and glass insulator strings with same structure arranged on the windward side is somewhat more severe than that arranged on the leeward side.

(5) The relationship between ice characteristics of ice-covered insulators and ice accretion time shows a nonlinearly growth. During the icing period, this growth degree is fast and then drops.

(6) The ice mass of composite insulator is related to structure. The large shed reduce the ice mass of insulator.

Thanks For Your Attention!