Suggestions on testing of fire resistant window’s twisting degree

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Abstract. The object of this work was to improve fire resistant window’s testing accuracy. Firstly, the backgrounds of twist degree of fire resistant window were reviewed according to GB 16809. Secondly, the main problems and suggestions were summarized including test platform’s fixing, hardware’s installing and height ruler’s operating. Thirdly, other potential problems were also analyzed as a supplement. More accurate twisting degree could be measured on the base of these suggestions. Further study should focus on relative standards’ revision.

1. Introduction
Fire protective window could be used to prevent the danger’s spreading in fire accident. On one hand, this window could keep the frame and window’s integrity to stop the fire and smoke’s permeating [1]. On the other hand, this window could insulate the heat and energy’s transmitting. The fire protective windows could be divided into fixed style fire window and automatic-closing fire window according to the closing type. The fire protective windows could also be divided into insulated fire window and un-insulated fire window based according to insulating effect [2].

Table 1. The twisting degree definition.

| Sample                                      | Parameter | Measuring tool          |
|---------------------------------------------|-----------|-------------------------|
| Different plane floors in tower             | Degree    | Common protractor       |
| Different curved surfaces in screw rod      | Length    | Common ruler            |
| Different front and back door surfaces      | Length    | Common height ruler     |
| Different front and back window surfaces    | Length    | Common height ruler     |
| Different sides of guide rail               | Length    | Special tool            |

The twisting degree could be used to characterize the twisting situation between different curved surfaces or different plane surfaces. According to Ga 16809-2008, twisting degree could be used to describe mobile fan’s four frames or four points’ distortion in automatic-closing fire window. The fixed fan’s twisting degree didn’t need to test. This parameter not only affected the window’s normal working in daily life, but also affected the window’s integrity and heat insulation in fire accident. During twisting degree testing, some problems were collected and the relative suggestions were offered respectively in this paper.

2. Problems and suggestions
According to the standard, the test equipment for twisting degree should be prepared including one test platform, three core clamps and one height ruler. Firstly, three points of mobile fan were marked as P1, P2 and P3 for three core clamps respectively while the last point was marked as P4. Secondly, three points of mobile fan were fixed on three core clamps upon the test platform. The height between point P4 and test platform’s surface was tested using height ruler. Thirdly, the fire resistant window was turned over and the other surface’s point P1’, P2’ and P3’ were also fixed on three clamps upon the test platform. The point P1 and P1’ were on fan’s symmetric point’s both sides. Then the other height between point P4’ and test platform’s surface was determined using height ruler [3]. Finally, the half of these two heights’ absolute difference value was calculated as twisting degree, which should be less than 3 mm according to GB 16809.

2.1 The test platform’s fixing

In theory, the test platform should be fixed to the area to keep the platform surface horizontal. The flatness degree should be less than 3 to ensure the twisting degree more accuracy. The relative parameters were shown to different test platforms with different flatness. However, the fixing area of test platform was often changed in fact. The reason was that the inspectors might move this platform for their convenient operation. Then some inaccuracy risks might be brought into the test.

| Size/mm      | Flatness 1 degree /μm | Flatness 2 degree /μm | Flatness 3 degree /μm |
|--------------|------------------------|------------------------|------------------------|
| 200×200      | 10                     | 20                     | 50                     |
| 300×200      | 12                     | 24                     | 60                     |
| 300×300      | 12                     | 24                     | 60                     |
| 300×400      | 12                     | 24                     | 60                     |
| 400×400      | 12                     | 24                     | 60                     |
| 400×600      | 14                     | 28                     | 70                     |
| 500×500      | 14                     | 28                     | 70                     |
| 500×600      | 14                     | 28                     | 70                     |
| 500×800      | 16                     | 32                     | 80                     |
| 600×800      | 16                     | 32                     | 80                     |
| 600×900      | 16                     | 32                     | 80                     |
| 1000×750     | 18                     | 36                     | 90                     |
| 1000×1000    | 20                     | 39                     | 96                     |
| 1000×1200    | 20                     | 40                     | 100                    |
| 1000×1500    | 24                     | 48                     | 120                    |
| 1000×2000    | 26                     | 52                     | 130                    |
| 1500×2000    | 28                     | 56                     | 140                    |
| 1500×2500    | 32                     | 64                     | 152                    |

To solve this problem, the test platform’s fixing area should be recorded including the calibrating record. If the platform was moved, the platform should be calibrated again to keep the flatness. In addition, the test platform’s size and the common difference to flatness 3 degree should also be in coincident. For example, the frequently used platform size was 1500×2000 and the common difference should be less than 0.14 mm.
2.2 The hardware's installing
Before the test, the hardware should be installed onto the fire resistant window. The main body of the window included the casement frame and the glass. The hardware included the opening and closing device, window closer, the hinges and the thumb lock. Before testing twisting degree using height ruler, the mobile fans’ situations were quite different.

Table 3. The weights of different equipment of fire resistant window.

| The different equipment | Weights | Additional part                      |
|-------------------------|---------|--------------------------------------|
| The corner combining with glass | 30 kg   | Fire in-tumescent seal               |
| The corner combining with glass | 45 kg   | Less inorganic fireproof filler       |
| The corner combining with glass | 60 kg   | More inorganic fireproof filler       |
| Closing device           | 2 kg    | Opening and closing device.          |
| Hinges                   | 1.2 kg  | One                                  |
| Thumb lock               | 1 kg    | One or more                          |

The hardware with lower weight was often asymmetrically installed on the mobile fan, while the casement frame and glass with higher weight were symmetrically installed. So the hardware had little influence on twisting degree. Even if the hardware might impact the result, there were some solutions.

Figure 2. The more added filler (red pot) to keep the balance of fire resistant windows corresponding to new added hardware like hinges or opening and closing device.

To solve this problem, the more added filler could be installed to keep the balance of the window. The filler could be the sealant or fireproof mud. The detail technical parameters should be probed to each factory. In most of the factory, the window’s corner combining, the glass and the hardware were transported respectively. In few factories, the window including corner combing, the glass and the hardware would be transported wholly to the target building sense. And the whole window should be treated carefully during the transporting.

2.3 The height ruler’s operating
To ensure the height difference, the height ruler’s measure-hand could be used to fix on either the upper surface or the lower surface of fire resistant window. According to GA 16809, the height ruler’s measure-hand should be below the lower surface. However, some operators in the factory prefer to
measure the upper surface of fire resistant window. It might be relative with the bending degree testing on the upper surface of fire resistant door as shown in Figure 3, which was different from the twisting degree testing on fire resistant window’s mobile fan in Figure 4.

![Figure 3](image)

**Figure 3.** The bending degree test of fire resistant door or fire resistant window using four core clamps.

![Figure 4](image)

**Figure 4.** The twisting degree test of fire resistant window’s mobile fan using three core clamps.

To solve this problem, the operator should know the difference of bending degree and twisting degree. The bending degree meant the bending situation of elongated shape object, while the twisting degree meant the four frames’ distortion situation of a plane object. The elongated shape object could be the sample like the steel rail, the wood bar or the iron plate. Therefore, these test methods including the number of core clamps, the test surface and the aided plumb bob were quite different. Although the test results might be similar using upper sample surface or lower sample, the operator should still use the height ruler to measure the distance between the lower sample and the test platform surface. Then the further regulations on the factory manual should emphasize this item on testing surface during twisting degree’s test.

### 3. Other potential problems and suggestions

Besides three main problems above, there were other potential problems during twisting degree’s test. For example, some operators often measure four points’ twisting degrees, but one point’s data were enough. Because three of the four points were fixed onto three core clamps on the test platform, the last fourth point’s data could present this sample’s plane situation no matter which point was the fourth point.

**Table 4.** The different points’ twisting degree.

| The point         | h1 mm | h2 mm | D=|h1-h2|/2 mm |
|-------------------|-------|-------|-----------------|-------|
| The first point   | 19.28 | 18.88 | 0.20            |
| The second point  | 19.34 | 18.78 | 0.20            |
| The third point   | 19.00 | 19.20 | 0.10            |
| The fourth point  | 19.00 | 19.20 | 0.10            |
For example, some operators often used adjustable core clamps as the aided tool for both fire resistant door and fire resistant door. However the adjustable core clamps were more suitable for fire resistant door’s blending degree. The unchangeable core clamps would be more suitable for fire resistant window’s twisting degree separately. Because four core clamps should be introduced to test blending degree and the fourth core clamp should be adjusted to keep all the four points’ balance, while only three core clamps were used to test twisting degree and core clamps could be unchanged.

![Figure 5. The core clamper.](image)

For example, many operators often measure the mobile fan’s twisting degree with the help of other operators. The other operator might put their hands to keep the balance of the mobile fan’s frame on three core clamps even when measuring the height. This action might affect the twisting degree’s accuracy. So the other operators could help before the measuring action, but this help was forbidden when measuring action. In addition, the height ruler’s dividing value was 0.02 mm and the micrometer data shouldn’t be read approximately.

4. Conclusion
In this paper, some suggestions were summarized on twisting degree. Firstly, the test platform should be calibrated after moving. Secondly, the installation technology should be optimized considering the asymmetrical installed hardware to keep the mobile fan’s balance. Thirdly, the operator should measure the distance between the fan’s lower surface and the test platform’s surface. Other suggestions on potential problems were also collected. The operators should follow the standard regulations strictly like the fan’s lower surface item. The factory manual items should be clear like the number of measuring point. Then more accurate twisting degree could be obtained considering these suggestions based on this paper. The further study should focus on new standard’s revision.

Acknowledgments
This paper is supported by Tianjin fire research institute’s basic scientific research project in 2018.

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