

**DETERMINATION OF INTERNAL COMPRESSION STRESSES IN THE EDGE ZONES  
OF LAMINATED GLASS WINDSHIELDS****Application**

This method is used to determine qualitatively and quantitatively the internal compression stresses in laminated glass windshields.

The qualitative determination of stresses - compression and tension – is performed according to the colour change method.

The quantitative determination of stresses is performed according to the compensation method. With the compensator wedge used according to this method, compression stresses are measured in the range of specification requirements for laminated windshields.

**Apparatus Required****Polariscope**

White light with a maximum intensity at the wave length of 550 nm; direction of polarisation foil (see Figure). Dimensions of the illumination field approximately 2.0 x 0.9 m.

**Analyser with Compensator Red I (536 nm)**

One half of the analyser is covered with Compensator Red I. Field of view 100 mm diameter minimum. Direction of polarisation foil (see Figure).

Note: Suitable analyser spectacles with and without Compensator Red I may be used depending on the respective case stated in the Test Procedure.

**Reflex Camera**

Commercial.

**Attachable Analyser**

Suitable to be fitted on the camera objective mount, consisting of Polarex Filter KS-DE (35 % light transmittance) and compensator Red I (536 nm) or equivalent.

**Supporting of Windshield**

The windshield supporting device must be such that all edge zones can be placed in a parallel position in front of the illumination field of the polariscope.

| Date       | Action  | Revisions                                  |
|------------|---------|--------------------------------------------|
|            |         |                                            |
| 2001 04 30 | Revised | Editorial – no technical change A. Cockman |
| 1999 01 19 |         |                                            |

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**Compensator Wedge**

For measuring compression stress, made of Plexiglass with face difference of 0.6 ratings linear increasing to the thick end (using white light with a maximum intensity at the wave length 550 nm); the wedge is provided with a compression stress scale calibrated in kN/m<sup>2</sup> corresponding with the individual windshield thickness (see evaluation example).

Compression Stress Range: 6000 - 16000 kN/m<sup>2</sup>.  
Scale Length approximately 10 cm.

Source: Unimatic Engineers Limited  
122 Granville Rd.  
London, UK NW2 2LN

**Checking of Proper Placement of Plane of Polarisation, Both of the Illumination Field of Polariscope and Analyser.**

1. The analyser is placed in front of the illumination field of the polariscope (see Figure).
2. Viewing the illumination field through the left segment of the analyzer (provided with Compensator Red I), the illumination field must appear "red" when using the prescribed polariscope.
3. Determine the thickness of the windshield in the edge zone in ten positions (three each on horizontal and two each on vertical edges) to the nearest 0.1 mm and compute the average.

**Conditioning and Test Conditions**

All test values indicated herein are based on material conditioned in a controlled atmosphere of 23 +/- 2 °C and 50 +/- 5 % relative humidity for not less than 24 h prior to testing and tested under the same conditions unless otherwise specified.

**Procedure**

1. The windshield under test shall be placed in the supporting device; the supporting device shall be positioned in such a way that:

The edge zone to be tested is placed parallel to the polariscope frame, i.e. under an angle of 45° to the foil direction of the polariscope, and

The windshield zone on the edge under test is placed parallel to the illumination field of the polariscope.

The distances between polariscope, windshield and analyser should be kept rather small to obtain optimum illumination effect.

2. The entire windshield edge is viewed through the analyser with Red I as specified (see Figure) and shall be investigated qualitatively for compression stresses all around the windshields.
  - (a) In cases of horizontal edges a colour tone in the blue range (see table) must appear at the outer edge areas. Mark on the windshield edge the point where the colour tone nearest approaches the Red I tone, this point being the lowest compression stress area.

The appearance of a yellow colour tone in these areas indicates tension stresses and shall be marked accordingly.
  - (b) In cases of vertical edges a colour tone in the yellow range (see Table) must appear at the outer edge areas. Mark on the windshield edge the point where the colour tone nearest approaches the Red I tone, this point being the lowest comparison stress area.

The appearance of a blue colour tone in these areas indicates tension stresses and shall be marked accordingly.
3. The marked compression stress areas are viewed without Red I through the analyser located as specified (see figure) and are quantitatively examined (using the compensator wedge provided for the relevant windshield thickness) for compression stresses and for the width of the compression stress zones.
  - (a) Determine the maximum width of the compression stress zone. This width is the greatest distance of the O-isochromate (first dark line parallel to the windshield edge) from the edge and is determined to an accuracy of  $\pm 1$  mm.
  - (b) The compression stresses on the marked points will be determined as follows:

Position the compensator wedge vertically to the windshield edge and view through the analyser without compensator Red I. The O-isochromate (dark line) visible in the compensator wedge is displaced by moving the thin end of the wedge in the direction of the windshield centre until the O-isochromate appears at the exterior edge zone, i.e. is being placed in compensation position.
4. In this compensation position the compression stress is read from the compensator scale (kN/m<sup>2</sup>) at the height of the windshield edge.

#### **Evaluation**

Report the area on which any tension stress has been found. The lowest compression stress value is quoted in kN/m<sup>2</sup> (see evaluation example). The maximum width of the compression stress zone is quoted in mm.

Note: If necessary, a reference photograph for the documentation of compression, or tension stress zones may be taken using the attachable analyser and wedge in measuring position.