Overall Review of CPA

(CPA : Ceramic Printed Area)

29. Sep. 2015
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1. Status of consumer defect complaints & media reports

- Status of Consumer defect complaints in Korea
  - The number of consumer defect complaints: **61** (2010~2015. 7)

  - Most defect complaints due to glass breakage seem to be placed on panoramic sunroof of a large glass size.
  - In terms of season, the glass breakage rate is high from June to September, of which temperature is high.

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• In terms of season, the glass breakage rate is high from June to September, of which temperature is high.
1. Status of consumer defect complaints & media reports

- Status of Consumer defect complaints in Korea
  - Analysis of Consumer defect complaints

- Analysis of accident cause

- Correlation between mileage and accident
  - High Accident Rate

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1. Status of consumer defect complaints & media reports

Media Reports in Korea

- Report about breakage of PSG (YTN, 14 July 2014)

- Response of the driver
  * The driver was shocked because he suddenly heard explosions like gunshots and then was not able to focus on driving for a while.
  * If there were other vehicles around his vehicle, that could lead to secondary accidents by hitting other vehicles.
1. Status of Consumer defect Complaints & Media Reports

- **Media Reports in USA**

  - Report about breakage of PSG

    <NBC_6 Aug 2015>  
    <ABC_7 Aug 2015>

  - **Response of the driver**

    * The driver felt very surprised because he suddenly heard explosions like gunfight
    * The driver was not able to see for a moment because glass pieces fell into vehicle like rain. There were even the case of eye injuries of driver.
1. Status of Consumer defect Complaints & Media Reports

Summary

- The main features of glazing breakage accidents are as follows
  - Accident rate is high during summer (July-August), in which sunshine is strong.
  - Accident rate is high when mileage (>20,000 km) is short.
  - Most of the complainants claimed self-explosion by unknown cause, some were hit by tiny stone and passing a speed-bump.

- The glazing breakages of sunroofs and Panoramic sunroof were worried about occupant injury risks and probability of secondary accidents by hitting other vehicles.
2. Status of CPA application in Korea

Survey of sunroof and Panoramic sunroof

- Toughened glass of sunroof (including panoramic sunroof) mounting on the vehicles sold in 2015 Korea market from the Korea vehicle manufacturer
  : Sunroof : 20 models, Panoramic sunroof : 21 models

- Panoramic sunroof of Top-loading type is placed on about 95% of panoramic sunroof models mounting on vehicles and about 99% of sales volume in Korea
2. Status of CPA application in Korea

- Survey of Ceramic Printed Area (CPA) in Sunroof
  - Average width of CPA at each location in sunroof glazing (20 models)

- Size and proportion of CPA sunroof glazing depending on vehicle type
2. Status of CPA application in Korea

- Survey of Ceramic Printed Area (CPA) in PSG
  - Proportion of CPA as a type of PSG (21 models)

![Bar chart showing CPA proportions for different types of PSG.]

- The top-loading type seems to have larger toughened glass sizes and ceramic printed applicable areas compared to the bottom-up type.
- In particular, unlike the bottom-up type, the top-loading type has a wider area of rear fixed glass and ceramic print applicable area.

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2. Status of CPA application in Korea

- Survey of Ceramic Printed Area (CPA) in PSG
  - Width of CPA at each location in movable glass of PSG

Excessive use

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2. Status of CPA application in Korea

- Survey of Ceramic Printed Area (CPA) in PSG
  - Width of CPA at each location in Rear fixed glass of PSG

  ![Graphs showing CPA distribution](image)

- Excessive ceramic printed width

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2. Status of CPA application in Korea

- Survey of Ceramic Printed Area (CPA) in PSG
  - Width of CPA at the center position in PSG

  - The location where two sheets of toughened glass adjoins becomes the center of a panoramic sunroof owing to the structural characteristics of a panoramic sunroof. Therefore, the width of ceramic printed area of that location shall be considered.
### 3. Strength Characteristics of CPA in Toughened glass

#### Manufacturing Process & Stress Distribution

<table>
<thead>
<tr>
<th>Process</th>
<th>Toughened Glass</th>
<th>Toughened Glass With CPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annealed glass</td>
<td>Heating</td>
<td>Quenching</td>
</tr>
<tr>
<td>Tempered glass</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Stress Distribution

1/ The toughened glass becomes to have unstable stress distribution, because ceramic prevents compression by adhering to toughened glass surfaces during tempering process.

☞ Becomes vulnerable in terms of the mechanical strength.
3. Strength Characteristics of CPA in Toughened glass

- **227g ball drop test** (in accordance with GTR No.6)

  - **Test Results**

<table>
<thead>
<tr>
<th>Glass Type</th>
<th>Annealed Glass</th>
<th>Toughened Glass</th>
<th>Ceramic Printed Toughened Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture Drop Height (m)</td>
<td>3.0 m</td>
<td>More than 10 m</td>
<td>1.4 m</td>
</tr>
</tbody>
</table>

The mechanical strength of ceramic printed toughened glass is weaker than that of annealed glass
3. Strength Characteristics of CPA in Toughened glass

- **Static Compressive Bending Test**

  - **Test Method**
    - Samples: Annealed, Toughened, Ceramic printed Toughened Glass
      - Sample size: 300 x 300 mm
      - Sample thickness: 4mm
    - Test Vel.: 10mm/min

  - **Test Results**

    | Glass Type                  | Annealed Glass | Toughened Glass | Ceramic Printed Toughened Glass |
    |-----------------------------|----------------|-----------------|--------------------------------|
    | Max. Displacement (mm)      | 2.81           | 3.87            | 2.63                           |
    | Fracture Strength (N/m²)    | 11,577         | 17,666          | 9,977                          |

- Strength of Ceramic printed toughened glass is 43% lower than that of toughened glass
4. Conclusions

- Toughened glass with ceramic printed area is more likely to be fractured because of its unstable stress distribution and low fracture strength.

- A sudden shattering of toughened glass at the roof of a vehicle puts drivers at risk and can cause secondary traffic accidents while driving.

→ Need to minimize the usage of ceramic printed area of toughened glass or find out other solutions.
Thank you for your attention!