The Development of PSS
(Pumpable Sheet metal Stiffener)
Introduction

This report contains follow items regarding
the PSS (Pumpable Sheet metal Stiffener) Penguin Stiffener #1190.

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What is the SS?

SS is Sheet metal Stiffener which enforce the outer panels of car such as door, fender and etc.

The application process of existing sheet metal stiffener (Die cut type)

Weld shop
- Press
- Weld

Paint shop
- Washing
- Pretreatment
- Washing
- E-coat
- Washing
- Baking oven
- Next painting then assemble

Apply SS by hand

The examples of the application

The structure of existing SS (Die cut type)

- SS
- Outer panel

- Rear gate
- Door
- Fender
- hood

- Tie material (Glass cloth)
  Check a deformation issued by cure and material shrinkage

- Bracing material (Heat curable epoxy resin)
  Enforce by curing

- Release paper
  Covering the tackiness surface. It is stripped when apply onto panel.
The concept of the development

Environmental requirement
- Cut down CO₂, & waste material

Automaker Requirement
Cut down the exhaust gas by reducing car weight: Due to decrease the steel thickness

- Keep collision safety using high-ten steel but deteriorate the stiffness of outer panel

Increase the requirement of SS (Sheet metal Stiffener)

Existing SS (Die cut type)
Waste material (Release paper), Intensive working, inadequate stiffness and corrosion problem due to drop the reinforcement by poor tackiness at the pre-treatment process

Increasing the requirement for pumpable type
- Cut down the waste material at line
- Reduce level of intensive working
- Ensure the application (Stiffness and anti-corrosion)
Goal of the introduction of PSS

**Cost reduction**
- Eliminate the labor cost due to automatic application of PSS.
- Eliminate the scrapping cost of the release paper for the mold stiffener.

**Improve quality**
PSS can be applied the part needed for reinforcement exactly.

**Weight reduction**
Decrease the thickness of the sheet metal with maintaining body stiffness by the use of PSS.
Design concept of PSS (Pumpable Sheet metal Stiffener)

The application process of PSS

Weld shop
- Stamping
- Welding
  Apply PSS by robot

Paint shop
- Pre-treatment
- Washing
- Baking oven
- E-coat
- Washing
- Next painting then assemble
  Curing the PSS

Anti-shower performance is the most important

Hot apply system

Control box

Heating nozzle (Controlled at 50°C)

Heating hose (Controlled at 45°C)

Heating hose (Controlled at 45°C)

Applied by 6 axial robot

High pressure pump with heat plate (controlled at 40°C)

Increase flowability due to heat the material at 45 to 50 °C. After applied, the material increase anti-shower performance due to be cooled and make higher viscosity.
**Basic property**

<table>
<thead>
<tr>
<th>Item</th>
<th>Test condition</th>
<th>Requirement</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness of applied (mm)</td>
<td>Thickness gauge</td>
<td>-</td>
<td>2.0</td>
</tr>
<tr>
<td>Non volatile matter (%)</td>
<td>105°Cx3hr</td>
<td>96 min.</td>
<td>99.8</td>
</tr>
<tr>
<td>Viscosity (Pa-s)</td>
<td>430 sec⁻¹ @40deg-C</td>
<td>(60-150)</td>
<td>100</td>
</tr>
<tr>
<td>Shear strength (MPa)</td>
<td>Standard 180deg-C x 30min.</td>
<td>13mm lap</td>
<td>-</td>
</tr>
<tr>
<td>Stiffness (N)</td>
<td>Standard 180deg-C x 30min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Over-baking 200deg-C x 60min.</td>
<td>specimen:40x150x0.8mm applied :25x150x2.0mm span of fulcrum : 100mm test speed : 5mm/min strength at 2mm displacement</td>
<td>60 min.</td>
</tr>
<tr>
<td></td>
<td>Under-baking 160deg-C x 30min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-crash resistance</td>
<td>Before baking slamming test</td>
<td>specimen:100x300x0.8mm applied :50x100x2.0mm</td>
<td>30 deg. x 1min.</td>
</tr>
<tr>
<td></td>
<td>After baking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aging property (%)</td>
<td>40 deg-C x 7 days</td>
<td>(30% max.)</td>
<td>+11%</td>
</tr>
<tr>
<td>Shower resistance</td>
<td>50deg.-C , 0.2MPa</td>
<td>(Not peeling off)</td>
<td>Good</td>
</tr>
<tr>
<td>Distortion (%)</td>
<td>specimen:200x25x0.7mm applied :150x25x2.0mm</td>
<td>2 max.</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

* Test conditions have been done according to your specification for formed type DWG #6711Z-SIF0000.
The effectiveness of the reinforcement

Bending stiffness

<table>
<thead>
<tr>
<th>Load (N)</th>
<th>Strain (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>0.5</td>
</tr>
<tr>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>150</td>
<td>1.5</td>
</tr>
<tr>
<td>200</td>
<td>2</td>
</tr>
<tr>
<td>250</td>
<td>2.5</td>
</tr>
</tbody>
</table>

- Blank
- Existing (Die cut type)
- 1000 μ
- 1250 μ
- 1500 μ
- 1800 μ

Stiffness vs. thickness

<table>
<thead>
<tr>
<th>Stiffness (N/10mm)</th>
<th>Thickness (μm wet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>500</td>
</tr>
<tr>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>150</td>
<td>1500</td>
</tr>
<tr>
<td>200</td>
<td>2000</td>
</tr>
</tbody>
</table>

- PSS
- Existing (Die cut type)
- SPCC (Blank)

The PSS is adjustable the stiffness due to control the thickness.

Three point bending test

- 5mm/min
- R=5mm
- 100mm
- R=2mm
## Baking Influence to Bending Stiffness

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Time</th>
<th>10min</th>
<th>20min</th>
<th>30min</th>
<th>60min</th>
</tr>
</thead>
<tbody>
<tr>
<td>140°C</td>
<td>10min</td>
<td>69</td>
<td>78</td>
<td>82</td>
<td>93</td>
</tr>
<tr>
<td>150°C</td>
<td>10min</td>
<td>80</td>
<td>85</td>
<td>88</td>
<td>98</td>
</tr>
<tr>
<td>160°C</td>
<td>10min</td>
<td>87</td>
<td>91</td>
<td>99</td>
<td>120</td>
</tr>
<tr>
<td>170°C</td>
<td>10min</td>
<td>95</td>
<td>100</td>
<td>111</td>
<td>127</td>
</tr>
<tr>
<td>180°C</td>
<td>10min</td>
<td>103</td>
<td>109</td>
<td>119</td>
<td>136</td>
</tr>
<tr>
<td>200°C</td>
<td>10min</td>
<td>111</td>
<td>117</td>
<td>122</td>
<td>125</td>
</tr>
<tr>
<td>210°C</td>
<td>10min</td>
<td>121</td>
<td>122</td>
<td>130</td>
<td>122</td>
</tr>
</tbody>
</table>

Unit: N

- **Substrate**: JIS G3141 SPCC-SD 100mm × 200mm × 0.8mmt
- **Material shape**: 50mm × 150mm × 1.5mmt
- **Baking condition**: 140°C10min ~ 210°C60min
- **Distance between supporting points**: 100mm
- **Bending speed**: 5mm/min

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Three point bending test

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100mm

5mm/min R=5mm
Outline of the application system

Drum Pump
40deg.C control
Decker corp.
SW7010
Ratio 70:1

High pressure gun with heater
@45 deg.C

Control Box

Heated hose 1B × 3m
45deg. C control

Heated hose 1B × 5m
45deg. C control

High pressure
are nozzle for
air press

6axis robot Capacity 20kg Yasukawa electric corp. UP-20

Rated flow pump
Decker corp.
Seagull

SUNSTAR